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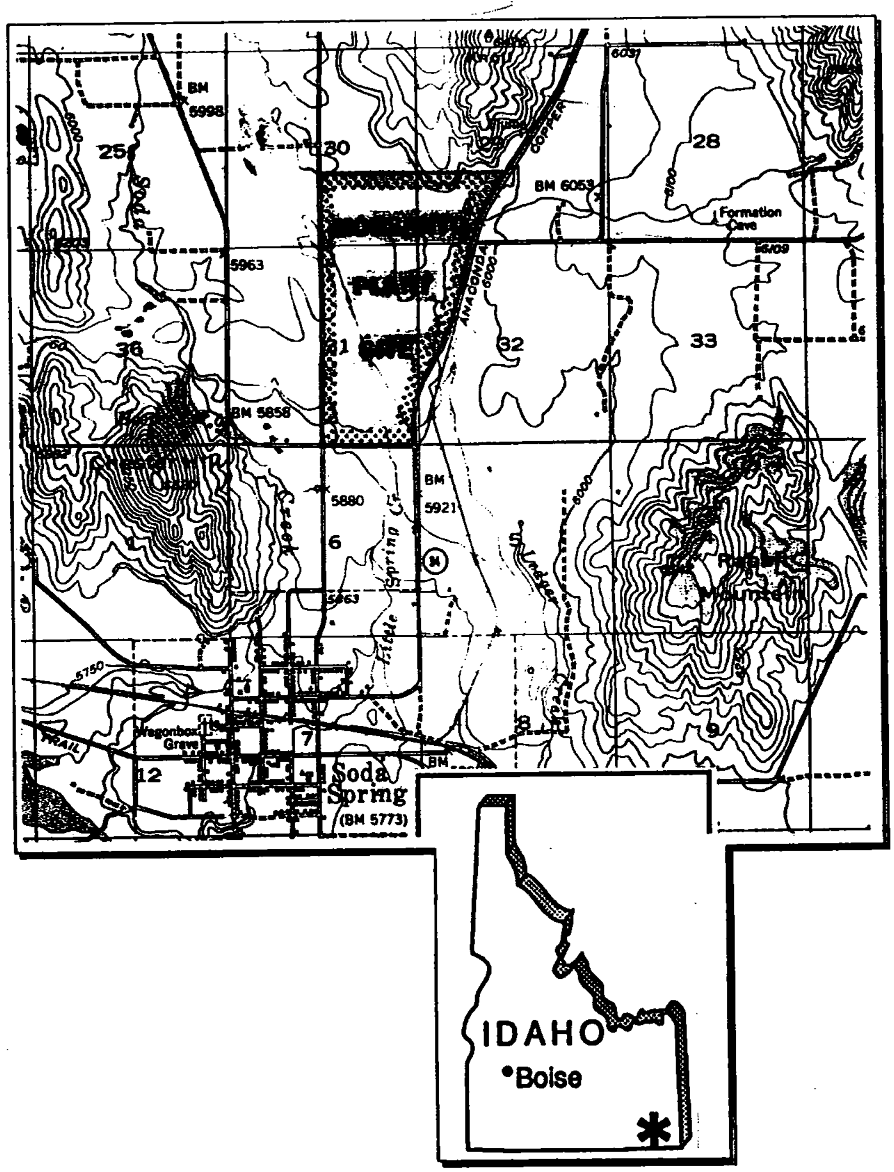
Submitted to:

Monsanto

Phase I Remedial Investigation/Feasibility Study

Remedial Alternatives Development and Preliminary Screening of Candidate Technologies Memorandum

for the Soda Springs Elemental Phosphorus Plant



Prepared by:

Golder Associates

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Golder Associates Inc.

2'04-148th Avenue, NE
Redmond, WA USA 98052
Telephone (206) 883-0777
Fax (206) 882-5498

Golder Associates

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June 5, 1992

Our ref: 913-1101.309

United States Environmental Protection Agency
1200 Sixth Avenue, 11th Floor
Seattle, Washington 98101

ATTENTION: Mr. Tim Brincefield

RE: SUBMITTAL OF PHASE I FEASIBILITY STUDY

Dear Mr. Brincefield:

Enclosed please find five copies of the Monsanto Remedial Alternatives Development and Preliminary Screening of Candidate Technologies Memorandum for the Soda Springs Elemental Phosphorus Plant.

If you have any questions or comments, please contact one of the undersigned.

Sincerely,

GOLDER ASSOCIATES INC.

J. Scott Kindred

J. Scott Kindred
Senior Hydrogeologist

D Banton

David Banton
Associate and Project Director

JSK/DB/ln

Enclosure

cc: R. Geddes, Monsanto - Soda Springs
D. Wilson, Monsanto - St. Louis

Golder Associates Inc.

4104-148th Avenue, NE
Redmond, WA USA 98052
Telephone (206) 883-0777
Fax (206) 882-5498

Golder Associates

PHASE I FEASIBILITY STUDY:

REMEDIAL ALTERNATIVES DEVELOPMENT AND PRELIMINARY SCREENING OF CANDIDATE TECHNOLOGIES MEMORANDUM

for

The Monsanto Soda Springs Plant

Prepared by:

Golder Associates Inc.

June 5, 1992

913-1101.309

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1. INTRODUCTION

In August, 1990, the United States Environmental Protection Agency (EPA) placed the Monsanto Company (Monsanto) elemental phosphorous plant in Soda Springs, Idaho, on the National Priorities List (NPL). The NPL is contained within Appendix B of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP, 40 CFR 300). The EPA took this action pursuant to their authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 USC §9601 et seq.). (Note: All regulatory and statutory citations within this report refer to the version of the regulation or statute in effect, as amended, on the date of report publication.)

An Administrative Order on Consent (AOC) was issued by the EPA, Region 10 (EPA-10), and agreed to by Monsanto on March 19, 1991, for the performance and preparation of a remedial investigation and feasibility study (RI/FS) for the Soda Springs Plant. Monsanto subsequently authorized Golder Associates Inc. (Golder) to prepare the Phase I RI report (Golder 1992), submitted to EPA-10 on April 24, 1991, and the Phase I FS, contained herein.

The RI/FS process under CERCLA is described in detail by the EPA RI/FS guidance document (EPA 1988a). The EPA dictates that the RI and FS are to be conducted concurrently and that the data compiled in the RI influence the development of remedial alternatives in the FS. The FS should thus direct data collection toward information necessary to evaluate remedial alternatives.

1.1 Purpose

The primary purpose of the Monsanto Plant Phase I FS is to identify preliminary remedial action objectives (RAOs) and develop preliminary remedial alternatives that could potentially satisfy these objectives. In addition, this report fulfills the requirement in the AOC for the Identification of Candidate Technologies Memorandum.

The RI/FS work plan identified 8 tasks for inclusion in the Phase I FS:

- Preliminary development of remedial action objectives
- Preliminary development of general response actions
- Preliminary identification of potential remedial technologies
- Preliminary evaluation of process options
- Preliminary assembly of remedial alternatives
- Preliminary identification of action-specific and location-specific applicable relevant and appropriate regulations (ARARs)
- Preliminary screening evaluation
- Reevaluation of data needs

These tasks are specified as preliminary because development of specific RAOs cannot be finalized until after the risk assessment is completed by EPA. Once the RAOs are finalized, then identification and evaluation of general response actions, remedial technologies, process options and remedial alternatives can be finalized.

1.2 Organization

This report is organized into seven sections:

Section 1 describes the content and purpose of the FS, as well as providing background information relating to the site history and operations. In addition, section 1 summarizes the results of the Phase I Remedial Investigation, including the nature and extent of constituents of interest, and the potential pathways of constituent migration.

Section 2 examines the RAOs for the media of interest including; source materials, soil, groundwater, surface water, sediments, and air. Remedial action objectives address specific routes of exposure, receptors, and maximum allowable constituent concentrations that provide a sufficient level of protection to human health and the environment. Because results of the risk assessment are not available, RAOs provided in this report are general in nature and will require later refinement.

Section 3 identifies the media-specific general response actions, remedial technology types, and process options that could potentially satisfy the RAOs outlined in Section 2. Preliminary estimates of the areas and volumes of media to which general response actions might be applied are assessed in this section. Remedial technologies are screened for technical implementability, and the process options are evaluated for their effectiveness, implementability, and cost.

Section 4 combines process options into remedial alternative systems designed to address the media of interest. Although some of the advantages and disadvantages of each remedial alternative system are discussed, a detailed evaluation and comparison will not be conducted until after the risk assessment is complete.

Section 5 outlines the action- and location-specific ARARs, environmental standards, criteria, and limitations that may apply to remedial actions at the site.

Section 6 summarizes the findings of the Phase I FS.

Section 7 contains a standard bibliographical listing of the references cited in the body of the text.

1.3 Background

The relevant physical characteristics for the region surrounding the Monsanto Plant are presented in subsection 1.3.1. A summary of the Plant operations is presented in subsection 1.3.2. More detailed discussions of these characteristics are presented in the Phase I RI report (Golder 1992).

1.3.1 Physical Site Characteristics

The Monsanto Plant is located in southeastern Idaho, approximately one mile north of the City of Soda Springs (Figure 1-1). The physical characteristics of the Plant and its vicinity are summarized below by environmental media. Figure 1-2 depicts the vicinity of the Monsanto Plant. Figure 1-3 depicts the details of the Monsanto Plant facility.

The regional setting for the Monsanto Plant varies in scale, depending on the environmental medium, however, it generally consists of the Bear River basin in southeastern Idaho, or the tributary valley to the Bear River in which the Plant is located.

1.3.1.1 Meteorology

The Monsanto Plant is situated within an area possessing a semiarid climate with hot summers and cold winters, characterized by relatively low precipitation, high evapotranspiration, and light winds.

1.3.1.2 Surface Hydrology

The major river in the vicinity of the Monsanto Plant is the Bear River, located approximately 2 miles to the south and southwest of the Monsanto Plant. Regional man-made surface waters include Alexander Reservoir and Blackfoot Reservoir. Natural local surface-water features in the Monsanto Plant vicinity include Soda Creek, Ledger Creek, Big Spring Creek, two wetland areas, and numerous springs and spring-fed ponds. Local man-made surface-water features include the ponds on the Plant site and Soda Creek Reservoir. Monsanto discharges their non-contact cooling water under a National Pollutant Discharge Elimination System (NPDES) permit, via subsurface pipeline into Soda Creek.

1.3.1.3 Geology

Regionally, the Monsanto Plant is located near the southern end of the Blackfoot Lava Field which has infilled a generally north-northwest trending valley bordered by the Chesterfield Range and the Soda Hills on the west, and by the Aspen Range on the east. The Plant is located within the Bear River graben. A series of north-northwest-trending normal faults extend from the southeast of the Plant northward to the Blackfoot Reservoir. The Plant is underlain at greater depth by an extension of the Paris Thrust fault.

Locally, the Plant property is underlain by a thin veneer of alluvial soils which overlie basalt flows of the Blackfoot Lava Field. Five basalt flows, separated by sedimentary interbeds or weathered basalt zones, have been identified beneath the Plant. The basalt flows vary in thickness from less than 10 feet to 80 feet. The sedimentary units and weathered basalt zones range from 1 to 23 feet thick. The basalt flows overlie the Salt Lake Formation.

Northwest trending, en-echelon normal faults (both west- and east- side-down relative displacement) are present in the Plant area and commonly form narrow grabens that are 1,000 to 1,500 feet wide and up to 2.5 to 3 miles long. Normal fault displacement has oftentimes offset permeable cinder zones and weathered basalt horizons against less permeable unweathered basalt flow interiors which may interrupt lateral groundwater flow and create springs. A prominent fault scarp enters the Plant near the northwest corner and appears to die out just west of the southeast corner of the Plant. A subsidiary fault parallels this fault approximately 1,500 feet to the southwest. In addition, several normal faults exist east of the Plant. These faults act as barriers to groundwater flow in places.

1.3.1.4 Pedology

The five soil types around the Monsanto Plant are similar in morphology and are primarily classified as mollisols. The soils are largely dominated by the characteristics of the loess parent materials from which they are derived and have similar particle sizes; the dominant particle-size class is silt-sized which is consistent with a loess parent material. The soils are classified as clayey silt with some sand and a trace of gravel. There is no appreciable difference between samples collected from the 0-to-1-inch depth interval and those collected from the 0-to-6-inch depth interval. The control soils are classified as clayey silt with some sand with no appreciable difference between the two depth intervals. Soils within the Plant are disturbed and cannot be correlated with the surrounding soils.

1.3.1.5 Hydrogeology

The Monsanto Plant is located at the southern end of the Blackfoot Lava Field. Four local hydrostratigraphic zones underlie the Monsanto Plant, including the Surficial Deposit Zone, the Upper Basalt Zone (UBZ), the Lower Basalt Zone (LBZ), and the Salt Lake Zone. The UBZ is the principal aquifer and is found most places beneath the Plant to a depth of about 100 feet below ground surface (bgs). The depth to the water table varies across the Plant from about 20 feet bgs in the northeast corner of the Plant to about 100 feet bgs in the center of the Plant. The LBZ is less permeable than the UBZ (with a hydraulic conductivity of at least three orders of magnitude less) and underlies the UBZ to a depth of at least 250 feet bgs.

Groundwater flow in the UBZ and the LBZ is influenced by faulting, regional hydrogeological conditions, and pumping of the Plant production wells. The groundwater flow direction beneath the Plant is generally to the south parallelling the geological structures. Both the major fault and the subsidiary fault running beneath the Plant appear to act as barriers to groundwater flow.

The ambient-groundwater quality beneath the Plant correlates to one of the three regional systems (the Shallow Groundwater System, the Mead Thrust Aquifer System, and the Chesterfield Range Aquifer System) or to a mixture of two of the systems, and can be described as either fresh or sodic. The Shallow Groundwater System consists of fresh water which comes into contact with surface soil and basaltic units. Based on groundwater quality and age-dating techniques, the age of this water is considered to be relatively young (7,000-13,000 years).

The Mead Thrust Aquifer System also consists of fresh water. The system receives recharge from the mountains to the east of the Monsanto Plant where the water is in contact with limestone country rock. The age of this water is considered relatively old compared to the Shallow Groundwater System (10,000-18,000 years). The Mead Thrust Aquifer System discharges along the eastern margin of the Blackfoot Lava Field via deep, normal faults.

The Chesterfield Range Aquifer System consists of sodic water. The system receives recharge from the Chesterfield Range to the west of the Plant where the water is in contact with limestone country rock. The age of this water has been proven to be the oldest of the three flow systems (greater than 20,000 years). The Chesterfield Range Aquifer System discharges along the western side of the Blackfoot Lava Field via deep, normal faults.

The UBZ and LBZ have been divided into smaller regions, based primarily on hydrogeological controls and groundwater quality, in order to facilitate the description of the local flow systems and plume characterization. The breakdown of the UBZ and LBZ regions is shown on Figures 1-4 and 1-5, respectively, and is described below, including source locations:

UBZ-1 & LBZ-1:

These zones are located in the immediate southwestern corner of the Plant and are bounded by the subsidiary fault to the northeast and, for the UBZ, the springs in the vicinity of Soda Creek and the Harris well located southwest of the Plant (see Figure 1-4). Plant facilities above these zones include the coke and quartzite dust slurry pond, the effluent settling pond and effluent ditch, and the sewage evaporation ponds.

UBZ-2 & LBZ-2:

These zones are located in the southwestern central portion of the Plant and are bounded by the major and subsidiary faults running beneath the Plant. The old underflow solids ponds are located above these zones.

UBZ-3 & LBZ-3:

These zones are included within the eastern and southeastern portions of the Plant and are influenced by Kerr-McGee operations.

UBZ-4 & LBZ-4:

The zones primarily underlie the northern and central portions of the Plant. Plant facilities located above these zones include the northwest pond and the old hydroclarifier.

UBZ-5:

This zone includes the springs located to the east of the Plant near Formation Cave and southeast of the Plant near Ledger Creek and Kelly Park (see Figure 1-4).

1.3.1.6 Ecology

The City of Soda Springs (population about 3,000) is located less than one-mile south of the Monsanto Plant (Figure 1-2). Land use within the city limits is mostly residential with some commercial, agriculture, and light industrial zones. A light and heavy industrial zone extends from the north end of the city along Route 34 towards the Monsanto Plant.

The Monsanto Plant is located outside of the city limits. The workforce populations for the Monsanto Plant and the adjacent Kerr-McGee Plant, respectively, are approximately 400 and 80 employees, respectively. The land use within the boundaries of the Monsanto Plant and the Kerr-McGee Plant is primarily industrial, surrounded by open agricultural and range lands.

The Monsanto Plant drinking water is supplied by production well PW-4 on the northern boundary of the Plant and upgradient of any known potential sources of constituent releases from the Monsanto operation. Kerr-McGee Plant drinking water is supplied, via the City of Soda Springs, by Formation Spring, located to the east and upgradient of the Monsanto and Kerr-McGee plants. The City of Soda Springs obtains its drinking water from Formation Spring and Ledger Springs, located to the southeast of the Monsanto Plant. Formation Spring is located upgradient of any known potential sources of constituent releases. Ledger Spring is cross-gradient of the Monsanto Plant and, based on hydrogeological interpretation and groundwater age-dating, is not threatened from potential sources of constituent releases from the Monsanto Plant. The nearest domestic well located downgradient of the Monsanto Plant (the Harris Well) is no longer used. The Lewis Well, located approximately 2,000 feet downgradient of the Monsanto Plant, is currently the nearest domestic well in use.

Areas of special historical interest in the vicinity of the Monsanto Plant include portions of the Oregon Trail and Hooper Spring, a soda-water spring. No other significant cultural resource or archaeological sites are known to exist within the vicinity.

The Monsanto Plant region is covered by sagebrush-grass vegetational zone. The hoary willow (Salix Candida) is the only sensitive plant species to exist in the Monsanto Plant vicinity (there are no documented endangered or threatened plants in the vicinity); this species is found along the Ledger Creek drainage.

The Idaho Fish and Game Department identifies several big-game animals in the Monsanto Plant vicinity. Significant fish and wildlife habitats include the Bear River, Alexander Reservoir, the Chester Field Range, the Aspen Range, and the Formation Cave vicinity (a property owned by the Nature Conservancy). Waterfowl are known to use the sewage evaporation and non-contact cooling water ponds at the Monsanto Plant throughout the year. Several fisheries are located in the area at Alexander Reservoir, the Bear River downstream of the reservoir, and the lower reaches of Soda Creek. The Natural Heritage Program Database was reviewed by the United States Fish and Wildlife Service- Boise Field Station (FWS-BFS), and the bald eagle was the only animal identified as a threatened species for the Soda Springs area (Lobdell, C., FWS-BFS, [Letter to W. Wright, Golder] December 2, 1991).

1.3.2 Overview of Operations

Monsanto purchased the Soda Springs site in 1952 and initiated elemental phosphorus production on the property. The Plant facilities include buildings, paved and unpaved areas and roads, railroad tracks, various utilities, ore stockpiles, by-product piles, and man-made ponds as shown on Figure 1-3. The Plant produces elemental phosphorus using electric-arc furnaces. The phosphorus is shipped off-site, where it is primarily used for the production of phosphoric acid. The general phases of phosphorus production are ore beneficiation and processing. A detailed description of the phosphorus production activities is provided in the RI.

1.4 Assessment of Environmental Effects

Several environmental investigations have been conducted by Monsanto to assess the environmental effects of Plant operations. These investigations, including the Phase I RI results, are summarized below by potential source areas and environmental media.

1.4.1 Potential Sources of Constituent Releases

The RI summarized the elemental phosphorus production process, including the primary materials used and the resulting by-products. Eleven raw material and by-product storage and disposal areas were characterized in the RI, and are shown in Figure 1-3. Five of these materials were identified as potential sources of constituent releases at the Plant and are described below:

- **Calcium silicate slag piles** - The slag consists primarily of calcium silicate and constitutes the greatest quantity of waste material at the Plant. This slag is poured as a molten material and cools as a solid mass. An estimated 23 million tons of slag are stockpiled at the Plant.

- **Baghouse dust** - Baghouse dust is the generic name given to dust collected by the many air pollution control units associated with the Plant. It is stockpiled in the northeast portion of the Plant.

- **Underflow solids** - Fine-grained particulate matter is removed from rotary-kiln exhaust gas by a spray-tower scrubber followed by high-energy venturi scrubbers. The resulting wet slurry is settled and dewatered in the hydroclarifier, resulting in underflow solids. The underflow solids are recycled in the process to recover their phosphate ore value. Underflow solids are stockpiled in the northeast portion of the Plant prior to recycling.

- **Coke and quartzite dust slurry pond** - Coke and quartzite dust was originally collected by a wet scrubber system associated with the coke and quartzite dryer and directed to a dewatering pond. This dewatering pond was taken out of service in 1987 when a new coke and quartzite dryer was operational. This new dryer is complemented with a dry scrubber/baghouse system, thus eliminating the need for a slurry dewatering pond.

- **Non-contact cooling water effluent** - Non-contact cooling water is used to control the furnace temperatures. The water passes over the outer furnace shell to maintain proper temperature and does not contact any process material. After leaving the furnace, the water passes through an effluent settling pond for cooling and is subsequently discharged via ditch and subsurface pipeline to Soda Creek under an NPDES permit. To assess the potential affects of the permitted, non-contact cooling water discharge into the Soda Creek ecosystem, Monsanto conducted a fathead minnow static bioassay (Grothe 1980). During the 96-hour duration of this test, no mortality was observed. No adverse effects to the environment have been attributed to date to the Monsanto non-contact cooling water discharged to Soda Creek.

There are several other significant industrial facilities in the vicinity of the Monsanto Plant. These include Kerr-McGee, a vanadium pentoxide production plant; two facilities which produce fertilizer products, Evergreen Resources and Soda Springs Phosphate Industries; Nu-West Industries, which produces phosphoric acid and fertilizer products; and N. A. Degerstrom, which is involved with gallium and silver extraction. Releases to the shallow groundwater system from Kerr-McGee wastewater impoundments have been documented (Ecology and Environment 1988b).

1.4.2 Soil Quality

Surface and subsurface samples were collected from soils surrounding the Monsanto Plant and from control points located approximately 13 miles southwest of the Plant in the Phase I RI. Samples were taken from two depth intervals: 0-to-1 inch (A group) and 0-to-6 inches (B group). Statistical analyses were performed on the soil data for each soil group to determine which parameters are elevated with respect to control concentrations. Each elevated constituent was subjected to a conservative preliminary risk screening to determine which are considered constituents of potential interest. This screening is summarized for non-radiological constituents and radiological constituents in Tables 1-1 and 1-2, respectively. The constituents of potential interest are:

- A group (0-to-1-in stratum) —

  Arsenic
  Beryllium
  Cadmium
  Lead-210
  Polonium-210
  Radium-226
  Thorium-230
  Uranium

- B group (0-to-6-in stratum) —

  Arsenic
  Beryllium
  Manganese
  Lead-210
  Polonium-210
  Radium-226
  Thorium-230
  Uranium

Although not every constituent shows the same spatial pattern, many of the constituents of potential interest are clustered around the north and south ends of the Plant. It is not conclusive that Plant activities are solely responsible for the elevated constituent concentrations.

1.4.3 Sediment Quality

Sediments were collected from Soda Creek at the diversion dam (approximately 100-feet downstream of the effluent discharge) in the Phase I RI. Results indicated that these sediments have elevated levels of the following constituents:

- Cadmium
- Copper
- Nickel
- Polonium-210
- Selenium
- Silver
- Vanadium

Sediment samples collected further downstream, approximately 300 feet below the effluent discharge, showed elevated levels of only selenium, silver, and vanadium.

At the present time there are no screening criteria, either risk-based calculations or regulatory guidelines, on which to judge the elevated constituents found in the sediment samples. Therefore, all elevated constituents in stream sediments are judged, at this time, to be constituents of potential interest.

1.4.4 Groundwater Quality

Previous environmental investigations for groundwater quality are discussed in Subsection 1.4.4.1. The results of the Phase I RI are discussed in Subsection 1.4.4.2, 1.4.4.3, and 1.4.4.4.

1.4.4.1 Previous Investigations

Monsanto installed five groundwater wells in 1978, and initiated a quarterly groundwater sampling program that continued until 1984. Two additional wells were installed downgradient of the first five wells in 1982. Some off-site spring sampling was conducted by Monsanto in 1983.

A series of hydrogeological and surface-water investigations were conducted by Golder from 1984 to 1988 (Golder 1985, 1987, 1988a, and 1988b) to assess the effect of past and current operations on groundwater and surface-water quality. The results of the Golder investigations indicated that groundwater beneath the Plant contained elevated concentrations of several metals and anions, including cadmium, selenium, fluoride, and sulfate. The sources of these constituents were determined to be the old underflow solids ponds, the northwest pond, and the hydroclarifier. The investigation also concluded that groundwater under the southeastern portion of the Plant contained elevated concentrations of vanadium and other constituents which, based on groundwater flow directions and geochemical data, are considered to be from an off-site source located to the east of the Monsanto Plant.

In April, 1988, a CERCLA site inspection was carried out and documented by EPA-10 (Ecology and Environment 1988a). The findings of the site inspection report, which included the results of additional groundwater sampling and analysis, were consistent with Monsanto's earlier findings (Golder 1985).

Groundwater from wells and springs at and in the vicinity of the Monsanto Plant were sampled and chemically analyzed during the Phase I RI. Control data were obtained from both fresh and sodic wells and springs up-gradient of any known sources of constituent releases on the Monsanto Plant. Fresh-quality groundwater exists in both the Shallow Groundwater Aquifer and the Mead Thrust Aquifer System. Sodic-quality water is found in the Chesterfield Range Aquifer System.

1.4.4.2 Constituents of Potential Interest

Statistical evaluations were performed to determine which constituents are at elevated levels in the Shallow Groundwater System and the Chesterfield Range Aquifer System. Subsequently, the elevated constituents were subjected to a conservative preliminary risk screening to determine which are considered constituents of potential interest. The screening is summarized in Table 1-3.

Effluent discharges from the Kerr-McGee Plant have increased constituent concentrations in the Mead Thrust Aquifer system upgradient of the Monsanto Plant. As a result, it is not possible to determine valid background concentrations for Monsanto wells in the Mead Thrust Aquifer System and statistical analyses were not performed on data collected from these wells.

Several constituents are only of potential interest because of welfare (i.e., aesthetic) considerations and are not expected to pose unacceptable health or ecological risks. These constituents (manganese, total dissolved solids, chloride, and sulfate), therefore, were eliminated from further consideration with respect to fate, transport, and detailed risk evaluation but may be considered as potential ARARs.

The phosphorus analysis performed for the Phase I RI measured total phosphorus in water. The actual form found in the groundwater is likely phosphate (PO_4), a soluble essential nutrient that is considered to be non-toxic at the concentrations found in groundwater beneath the Monsanto Plant. The screening criterion used for phosphorus in this assessment are applicable for elemental forms of phosphorus, therefore, phosphorus in groundwater was eliminated from further consideration in the Phase I RI.

The constituents of potential interest are:

- Constituents of potential interest in groundwater:

  Arsenic
  Cadmium
  Nickel
  Selenium
  Zinc
  Ammonium
  Fluoride
  Nitrate/nitrite
  Radium-226

1.4.4.3 Nature and Extent of Constituent Plumes

The nature and extent of the constituent plumes that were identified in the Phase I RI for each of the two basalt zones are described below:

- UBZ-1 - Control-groundwater quality for this region consists of sodic water and mixed sodic and fresh water, as defined in the Phase I RI. The constituents of potential interest (with concentrations exceeding appropriate risk-based criteria) found in UBZ-1 were cadmium, selenium, and fluoride.

- UBZ-2 - Control-groundwater quality in UBZ-2 is assumed to be fresh (Shallow Groundwater System). This assumption is based on the fact that a well downgradient of this region (Lewis Well) is used as a drinking-water supply. There are, however, no wells located upgradient of the region. The constituents of potential interest in UBZ-2 are cadmium, selenium, zinc, ammonium, and fluoride. Based on available groundwater elevation and chemical data, the plumes which appear to be emanating from the old underflow solids ponds have migrated off-site. Elevated levels of cadmium, selenium, and fluoride are found in the wells located along the southern Plant boundary downgradient of the source area.

- UBZ-3 - Control-groundwater quality in UBZ-3 is fresh, and is assumed to be that of the Mead Thrust Aquifer System with minor mixing with the Shallow Groundwater System. However, this zone is influenced by operations at the Kerr-McGee Plant, located to the east of the Monsanto Plant. Based on available groundwater elevation and chemical data, plumes of vanadium and ammonium, which appear to be emanating from east of the Plant, have migrated onto and south of the Monsanto Plant. For the reasons discussed in the previous section, statistical analyses of chemical data were not deemed appropriate for this region. Concentrations detected on the Monsanto property were less than those detected in the upgradient Kerr-McGee wells.

- UBZ-4 - Control-groundwater quality in UBZ-4 is primarily fresh (mostly Shallow Groundwater System), however, the groundwater quality in the immediate northwestern corner of the Plant is sodic. The constituents of potential interest that were found within UBZ-4 are cadmium, manganese, selenium, zinc, and fluoride. Based on available groundwater elevations and chemical data, the plumes emanating from the northwest pond and the old hydroclarifier are captured by the production wells located in the center of the Plant, preventing further southeasterly plume migration.

- UBZ-5 - Control-groundwater quality in UBZ-5 is a mixture of the two fresh flow systems (Mead Thrust Aquifer System and Shallow Groundwater System). Based on available groundwater elevation and chemical data, the plumes of vanadium, ammonium, which are emanating from east of the Monsanto Plant and were discussed for region UBZ-3 above, appear to be migrating toward Finch Spring.

- LBZ-1 - Control-groundwater quality in this region is sodic. No constituent concentrations were found to exceed screening levels in LBZ-1.

- LBZ-2 - Control-groundwater quality for this region is sodic. Constituents of potential interest in LBZ-2 are cadmium, zinc, and fluoride. These constituents of potential interest are also present at in the UBZ at the same location.

- LBZ-3 - Control-groundwater quality for this region is the Mead Thrust Aquifer System type but is influenced by operations at the Kerr-McGee Plant. Constituents of potential interest in LBZ-3 are vanadium and ammonium. As discussed for UBZ-3, the concentrations of detected constituents in this region are less than those found in Kerr-McGee wells and, therefore, the concentrations found on the Monsanto property in this region are not considered elevated. These same constituents of potential interest are also present in the UBZ at the same location.

- LBZ-4 - Five production wells and two monitoring well are located in this region. The production wells are open to both the LBZ and the UBZ, while the monitoring wells are only open in the LBZ. Groundwater quality for this region is primarily sodic. Water quality data is unknown in the northeastern and immediate center portions of the Plant. Constituents of potential interest in LBZ-4 are cadmium and fluoride. However, these constituents were found at elevated levels only in the productions wells located in the central portion of the Plant which produce groundwater primarily from the UBZ, due to the higher hydraulic conductivities in the UBZ. The constituents of potential interest are, therefore, assumed to be found in the UBZ and not the LBZ for this region.

1.4.4.4 Temporal Changes in Constituent Plumes

The temporal trends of constituents of potential interest were evaluated in the Phase I RI. The temporal trend in UBZ-1 indicates a decrease in concentration with respect to cadmium but an increase with respect to chloride and sulfate, which suggests that the evaporation/percolation sewage ponds are affecting groundwater quality in UBZ-1. Data indicate that the mass of the plume appears to be migrating off-site in a southerly direction.

Concentrations at the source area (old underflow solids ponds) in UBZ-2 have been decreasing with time, with the exception of fluoride which has reached an equilibrium. The mass of the plume has migrated in a southerly direction as indicated by increased concentrations along the southern Plant boundary and appears to be migrating off-site.

The plume in UBZ-3 originates off-site to the east of the Monsanto Plant. The plume is increasing in concentration and is also migrating to the south off-site. The plume in UBZ-4 is decreasing in concentration and is being captured by the production wells located in the central portion of the Plant, preventing further southeasterly plume migration.

The groundwater quality in LBZ-2 was affected in the past by hydraulic communication between LBZ-2 and UBZ-2. The associated wells have since been abandoned, in accordance with regulatory standards, and the resulting plume in LBZ-2 has been decreasing in concentration.

The plume in LBZ-3 originates east of the Monsanto Plant, is increasing in concentration and appears to be migrating to the west-southwest.

1.4.5 Surface-Water Quality

The State of Idaho reported the highly mineralized and carbonated water of Hooper Springs, and other sodic springs above Hooper springs, have a natural but severe impact on the aquatic life in Soda Creek, including decreased diversity of the benthic macroinvertebrate community in the creek. The creek slowly recovers from this impact, which is noted down to and beyond the confluence of the Monsanto NPDES-permitted, non-contact cooling water discharge into Soda Creek (Perry, J., IDHW-Division of Environment [Memo to G. Hopson, IDHW-Division of Environment] March 22, 1976).

This study also included a fish survey which noted an absence of fish in the upper portions of Soda Creek. This was interpreted as an indication of a population that was severely reduced due to the harsh environmental conditions imposed by Hooper Spring. Small numbers of fish (salmonids) were noted in the lower reaches of the creek, about one mile above the confluence with the Bear River.

Surface water from Soda Creek and the irrigation canal, associated sediments, and Monsanto Plant effluent were sampled and analyzed in the Phase I RI. Statistical analyses were performed on the water and sediment data to determine which downstream parameters are elevated with respect to upstream concentrations. The elevated surface water constituents include:

- Calcium
- Chloride
- Sodium
- Nitrate/nitrite
- Sulfate
- Total dissolved solids

None of these elevated constituents found in Soda Creek downstream of the effluent discharge exceed preliminary risk-based screening criteria. Therefore, no constituents of potential interest are identified for this medium.

1.4.6 Air Quality

Air dispersion modeling of cadmium and fluoride emissions from a limited number of sources was completed by Monsanto in 1988 (Cheng, C.K., Monsanto [Memo to F.R. Johannsen, Monsanto] April 12, 1988 and May 17, 1988). The sources modeled included the three furnace taphole fume collectors, the nodule crushing and screening venturi scrubber, the kiln cooler spray tower, the four nodule kiln venturi scrubbers, and fugitive emissions from the slag dumping area. The modeling was conducted using the long-term version of the EPA Industrial Source Complex Model.

The calculated annual average concentrations of cadmium and hydrogen fluoride in the surrounding community and at specific geographic locations were below the Threshold Limit Values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) for workplace exposure levels (ACGIH 1991). However, it was recognized that more precise studies of emission rates were required to validate the emission values used in the dispersion calculations.

A detailed series of particulate stack monitoring tests were conducted from 1989 through 1991 for the following sources:

- Kiln venturi scrubbers
- Nodule cooler spray tower
- Scale room baghouse outlet
- Nodule crushing and screening venturi scrubber
- Nos. 7, 8, and 9 taphole fume collectors

In addition, tests were conducted for fugitive particulate emissions from the nodule stacking and reclaim area, and for stack emissions of radionuclides at the four kiln venturi scrubbers (an earlier study of radionuclide emissions was conducted by the EPA in 1982). The results of the stack sampling indicate that cadmium and fluoride are constituents of most interest at the Plant.

Ambient air quality monitoring data for particulates are available from three monitoring stations operated by the Idaho Department of Health and Welfare, Division of the Environment, Bureau of Air Quality (IDHW-BAQ) in the immediate vicinity of the Monsanto Plant (see Figure 1-6). These include 24-hour measurements of total suspended particulates (TSP) using high volume air samplers at:

- The Harris Ranch (Station 13-0420-026), south of the Monsanto property, from January 1986 to May 1988

- Two miles north of Hooper Springs (Station 13-029-0029), northwest of the Monsanto property, from January 1986 to September 1988

- Soda Springs Hospital (Station 13-0420-021), located approximately two miles southwest of the Monsanto property, from January 1986 to September 1988

In addition, ambient concentrations of inhalable particulates (PM_{10}) have been measured at the Terrace Acres Mobile Court (Station 16-029-0030) south of the Monsanto property, since November, 1989. Ambient monitoring data are also available from the following two monitoring stations located near Conda, northeast of the Monsanto facility:

- The Torgesen residence (Station 13-029-0002) — TSP monitoring from January 1986 to September 1988

- 1.2 miles east of State Highway 34 (Station 13-0420-027) — TSP monitoring from January 1986 to September 1988, and PM_{10} monitoring from January, 1987, to June 1989

The indicator parameters, TSP and PM_{10}, were also used to evaluate the potential for off-site migration of cadmium and fluoride. The air monitoring results indicate that TSP concentrations exceeded primary and secondary standards only during periods of road upgrading and field burning, and not in association with Plant activities.

1.4.7 Biota Quality

Terrestrial ecological research was done by Severson and Gough (1979) in which soils and vegetation in the vicinity of the Monsanto Plant were sampled and analyzed. This study found that elevated plant tissue concentrations of cadmium, chromium, fluorine (as fluoride), selenium, uranium, vanadium, and zinc were associated with phosphate-processing operations; and elevated plant tissue concentrations of lithium, nickel, phosphorus, and sodium may be associated with the processing operations. Only chromium, zinc, and possibly fluorine (as fluoride) were found within ranges documented as being toxic to some plants; and only cadmium and fluorine (as fluoride) might have been present in sufficiently high concentrations to be toxic to grazing animals. Concentrations of chromium, vanadium, and zinc could potentially be high enough to be toxic. Elevated plant tissue concentrations were found predominantly within 2.5 miles (4 kilometers) of the Monsanto Plant. There were no formal biotic investigations conducted for the Phase I RI.

1.5 Remedial Measures

Monsanto instituted several remedial measures in response to needs identified in previous environmental investigations. The remedial measures that have been instituted at the Plant are described in Subsection 1.5.1, and the remedial measures that are planned for the Plant are described in Subsection 1.5.2.

1.5.1 Previous Measures

During and subsequent to the environmental investigations, Monsanto independently instituted a number of remedial measures at the Plant. EPA-10 and the State of Idaho were advised of these measures prior to or during their implementation, although no determination as to their adequacy or effectiveness has been made by either agency. The measures included the following:

- The old hydroclarifier, which was suspected as potentially affecting groundwater, was replaced in August, 1985, with a unit that included a synthetic liner, a leachate collection system, and a monitoring well network.

- An old coke and quartzite dryer and wet scrubber was replaced with a more efficient dryer and baghouse dust collector in 1986, resulting in an emission reduction of over 95 percent.

- A pollution control project was installed in September, 1987, to provide additional scrubbing of kiln exhaust emissions. This installation is comprised of four parallel high energy venturi scrubbers, four separators, four fans and four stacks. The parallel arrangement of equipment effectively reduces upset/breakdown emissions that would occur if only one or two fans existed. This project resulted in a reduction of particulate emissions in the 95 percent range. This equipment, coupled with a five-deck spray tower and dust dropout chamber located upstream, provides a cumulative cleaning efficiency of 99.9 percent.

- Four wells were discovered to be creating hydraulic communication between upper and lower aquifers and were abandoned (by drilling out and sealing to the surface with a cement/bentonite grout) in 1987, in accordance with regulatory guidelines (Golder 1987).

- The old underflow solids ponds, sources suspected to be affecting groundwater, were taken out of service in 1983. The solids (essentially low-grade ore) were subsequently excavated and recycled. The ponds were filled with molten slag and sealed with a bentonite cap in 1988 to isolate the ponds, and the residual material in them, from the groundwater system.

- The northwest pond, which was also suspected to be affecting groundwater, was excavated to remove affected soils. Measurements were taken to determine the depth that soils were affected, and soils were removed to that depth and deposited in the old underflow solids ponds. The base of the pond was sealed with bentonite in 1988. The northwest pond area is currently permitted by the IDHW to receive Plant sanitary solid waste.

- A new Plant drinking water well was installed upgradient of all known and suspected source areas to prevent affects to the Plant potable water supply. A new independent potable water distribution system was installed at the same time as the new well, thus preventing cross-connection of potable and raw process water at the Plant.

- Several wells were also installed around the hydroclarifier and used as recovery wells to intercept affected groundwater. The groundwater was pumped into the new hydroclarifier. Three wells were pumped intermittently at a rate of approximately 12 gallons per minute (gpm) per well from 1985 to 1989. Although these wells were turned off in the spring of 1989, pumping of PW-1 to supply process make-up water for the Plant intercepts groundwater migrating from the hydroclarifier.

- Fugitive emissions from the baghouse dust disposal pile located in the north end of the plant have been reduced through improved handling procedures and the placement of crushed slag on the surface of unused portions of the pile. These practices were begun in 1990.

Because of the nature of the operation of the Monsanto Plant and the high process demand for electricity, transformers and other electrical equipment containing insulating fluids have been used extensively. A complete file dating back to 1978 is maintained at the Plant. This file includes a history of service, inspections, fluid characteristics, and the retirement of the fluids and the transformers.

Efforts have progressed over the last several years to have the Plant become polychlorinated-biphenyl- (PCB-) free by initiating a comprehensive sampling program and replacing PCB-containing equipment. As transformer fluids were found to contain regulated levels of PCBs, accepted methods of treatment or off-site incineration were contracted to reputable companies who specialize in PCB/transformer management.

During the summer of 1991, EPA-10 completed a PCB inspection at the Plant. All records from the past five years were inspected and found to be in order. Monsanto received notification from EPA-10 (Haselberger, G., EPA-10 [Letter to R. Mahoney, Monsanto] September 25, 1991) regarding the inspection. EPA-10 informed Monsanto that there were no apparent violations of the PCB regulations, and that the Plant case was closed.

Finally, four underground storage tanks were replaced with above-ground tanks with concrete sumps in 1986. These tanks were removed solely to comply with new regulations, and there was no indication — either in the inventory control process, or during the inspection upon removal — that they had leaked.

1.5.2 Pending Measures

Monsanto is currently planning to institute further environmental improvement measures at the Plant. Measures that are currently scheduled include:

- The sewage lagoon will be taken out of service in the summer of 1992. The Plant will be hooked into the City of Soda Springs sewer system at that time.

- The nodule reclaim area will undergo emission controls to reduce fugitive emissions in the summer of 1992.

2. PRELIMINARY REMEDIAL ACTION OBJECTIVES

Preliminary remedial action objectives (RAOs) for the Monsanto Plant were developed for the constituents of potential interest according to environmental media. As noted in the RI, the ongoing Plant operations are in compliance with applicable state and federal regulations and will not be addressed by the RAOs developed for the FS. Examples of Plant operations include permitted stack emissions and fugitive dust generated by material handling. The RAOs are intended to protect human health and the environment based on existing information gathered during the RI concerning:

- The constituents of potential interest for each media
- The exposure pathways
- The acceptable risk-based constituent concentrations, in regards to protecting human health and the environment, for each exposure route.

The RAOs for the Monsanto Plant were developed on a preliminary basis, pending the results of a site risk assessment to identify the constituent concentrations associated with unacceptable levels of risk.

The constituents of potential interest for the Monsanto Plant are listed with their associated environmental media in Table 2-1. This list of constituents was based upon a variety of information sources and may include constituents that pose no threat to humans or the environment, or that are naturally occurring. The list is preliminary and may be changed as a result of information gathered during further investigations.

The media of interest include source materials, soil, groundwater, surface water, sediments, and air. Source materials consist of solid materials in all cases except the non-contact cooling water. Due to similarities in form, sampling techniques, and applicable remedial technologies, the source areas are included in the soils section, with the exception of the non-contact cooling water effluent which is included in the surface water section.

2.1 Preliminary Remedial Action Objectives for Source Materials and Soil

The source materials that were identified in the Phase I RI to be potential sources of constituent releases are listed below:

- Calcium silicate slag piles
- Baghouse dust
- Underflow solids
- Coke and quartzite dust slurry ponds
- Non-contact cooling water effluent

This list is preliminary and may require refinement based upon information gained during remedial investigations. The non-contact cooling water effluent will be discussed as a potential source in the surface-water subsection because it would be handled in a similar manner as surface water. Although analytical data are available for the source materials, there are no control data for comparison purposes. Therefore, the constituents of potential interest in the source areas are not defined at this time.

The soils were divided into two groups: the 0-to-1-inch soil group (A Group), and the 0-to-6-inch group (B Group). The maximum concentrations of the elevated constituents were compared to risk-based criteria in the Phase I RI. The constituents that exceeded the criteria were identified as constituents of potential interest, and are presented with the risk-based criteria in Tables 1-1 and 1-2 for non-radiological and radiological constituents, respectively. The criteria are based upon chemical-specific ARARs, and risk screening, as discussed in the Phase I RI. The constituents of potential interest in each soil group, as identified in the Phase I RI, are listed below:

- Constituents of potential interest in A Group soils

  Arsenic
  Beryllium
  Cadmium
  Lead-210
  Polonium-210
  Radium-226
  Thorium-230
  Uranium

- Constituents of potential interest in B Group soils

  Arsenic
  Beryllium
  Lead-210
  Manganese
  Polonium-210
  Radium-226
  Thorium-230
  Uranium

The exposure pathways associated with the soils and source materials are listed below:

- Direct contact with soils and source material

- Ingestion of soils and source materials

- Inhalation of fugitive dust from soils and source materials

- Ingestion of crops or cattle fed with crops grown in the agricultural fields adjacent to the Monsanto Plant
- Ingestion of groundwater derived from infiltrating precipitation passing through soils and source material.

The general RAOs for source materials and soil are listed below:

- Prevent ingestion, inhalation, or direct contact with source materials and soils that result in cancer risk in excess of the 10^{-4} to 10^{-6} range, or in exposure to toxic materials in excess of reference doses for critical constituents of potential interest.
- Prevent release and migration of hazardous substances from source materials and soil that results in failure to achieve RAOs for other media identified at the Plant (groundwater, surface water, sediments and air).

2.2 Preliminary Remedial Action Objectives for Groundwater

The maximum concentrations of elevated constituents in each groundwater type were compared to risk-based criteria in the Phase I RI. The constituents that exceeded the criteria were identified as constituents of potential interest. The constituents of potential interest in groundwater, and the risk-based criteria are presented in Table 1-3. The criteria are based upon chemical-specific ARARs, and risk screening, as discussed in the Phase I RI. As stated in the RI/FS guidance document (EPA 1988b), the cumulative cancer risk for all constituents must be less than the 10^{-4} to 10^{-6} range. Aquatic freshwater toxicity limits are not directly applicable to groundwater until it discharges to a surface water body.

Several constituents (manganese, chloride, sulfate and phosphorus) that were considered to be of potential interest because of welfare (i.e., aesthetic) considerations are not expected to pose unacceptable health or ecological risks, and are therefore eliminated from further consideration with respect to fate, transport, and detailed risk evaluation. These constituents are, however, retained in the evaluation of potential ARARs, and are included in Table 2-1.

The constituents of potential interest as identified in the Phase I RI, are listed below:

- Constituents of potential interest in groundwater

  Ammonium
  Arsenic
  Cadmium
  Fluoride
  Nickel
  Nitrite/Nitrate

Radium-226
Selenium
Zinc

The exposure pathways associated with groundwater are listed below:

- Human ingestion of groundwater at the Lewis Well; although only fluoride, nitrate/nitrite, and zinc are detectable in this well at the current time, and their current concentrations are well below established drinking water standards.

The general RAOs for groundwater are listed below:

- Prevent ingestion, inhalation, or direct contact with groundwater that results in a cancer risk in excess of the 10^{-4} to 10^{-6} range, or in exposure to toxic materials in excess of reference doses for critical constituents of potential interest.

- Prevent release and migration of hazardous substances from groundwater that results in failure to achieve RAOs for other media identified at the Plant (soils, surface water, sediments, and air).

2.3 Preliminary Remedial Action Objectives for Surface Water and Effluents

The maximum concentrations of the elevated constituents in surface water downstream of the non-contact cooling water effluent discharge were compared to risk-based criteria in the Phase I RI. None of the constituents exceeded the criteria, and therefore there are no constituents of potential interest identified for surface water. The exposure pathways for surface water are considered to be insignificant.

The non-contact cooling water effluent was identified in the Phase I RI as a potential source of constituent releases. The constituents of potential interest in the effluent and the exposure pathways are not defined at this time. The general RAOs for surface water and effluents are listed below:

- Prevent ingestion, inhalation, or direct contact with surface water and effluents that results in a cancer risk in excess of the 10^{-4} to 10^{-6} range, or in exposure to toxic materials in excess of reference doses for critical constituents of potential interest.

- Prevent release and migration of hazardous substances from surface water and effluents that results in failure to achieve RAOs for other media identified at the Plant (soils, groundwater, sediments, and air).

2.4 Preliminary Remedial Action Objectives for Sediments

Elevated concentrations of constituents were identified in the sediments downstream of the non-contact cooling water effluent discharge. Because there are no risk-based criteria with which to compare the concentrations of the elevated constituents, the elevated constituents will be considered constituents of potential interest in FS evaluations.

The elevated constituents in downstream sediments in Soda Creek are listed below:

Cadmium
Copper
Nickel
Polonium-210
Selenium
Silver
Vanadium

The exposures pathways associated with downstream sediments in Soda Creek are listed below:

- Direct contact with downstream sediments of Soda Creek
- Ingestion of downstream sediments
- Ingestion of crops and cattle fed with crops grown in agricultural fields irrigated with water from Soda Creek.

The general RAOs for sediments are listed below:

- Prevent ingestion, inhalation, or direct contact with downstream sediments that results in a cancer risk in excess of the 10^{-4} to 10^{-6} range, or in exposure to toxic materials in excess of reference doses for critical constituents of potential interest.
- Prevent release and migration of hazardous substances from sediments that results in failure to achieve RAOs for other media identified at the Plant (soils, groundwater, surface water, and air).

2.5 Preliminary Remedial Action Objectives for Air

Since no formal air investigations were performed in the Phase I RI, there were no constituents of potential interest identified. However, based on pre-existing stack emissions data, cadmium and fluoride were identified as constituents of interest for the Monsanto Plant. In addition, the indicator parameters TSP and PM_{10} were characterized to identify the extent of particulate effects associated with the Monsanto Plant.

The exposure pathways associated with air are listed below:

- Inhalation of cadmium and fluoride derived from fugitive dust
- Deposition of fugitive dust on soils, followed by the pathways indentified for soils in Section 2.1.

The general RAOs for air are listed below:

- Prevent inhalation or direct contact with air that result in cancer risk in excess of the 10^{-4} to 10^{-6} range, or in exposure to toxic materials in excess of reference doses for critical constituents of potential interest.
- Prevent release and migration of hazardous substances from air that results in failure to achieve RAOs for other media identified at the Plant (soils, groundwater, surface water, and sediments).

3. IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section of the FS identifies and screens a range of remedial technologies that apply to each media of interest to determine which technologies are appropriate for development of remedial alternatives. The technologies are selected to ensure the protection of human health and the environment.

The technologies will be evaluated to determine if they could help satisfy one or more remedial action objectives specified in Chapter 2. The technologies, or combinations of technologies, resulting from the screening process will be assembled into alternatives that address remediation on a site-wide basis. The process for identifying and screening technologies for remedial alternative development consists of five steps discussed below (EPA 1988a):

1) Identify volumes and areas of media to which general response actions might be applied, taking into account the general cleanup goals established with the remedial action objectives in Chapter 2, and the chemical and physical characterization of the site as described in the RI.

2) Identify general response actions for each medium of interest. General response actions are broad categories of remedial approaches and may include: no action, institutional actions, containment, collection, disposal, removal, stabilization, or treatment.

3) Identify remedial technology types included within each general response action and eliminate those that cannot be technically implemented at the site.

4) Identify process options included within each technology type retained for consideration. Process options will be qualitatively evaluated and compared for effectiveness, implementability and cost. The most favorable process options will be retained for incorporation into remediation alternatives described in Chapter 4.

5) Assemble the most promising process options into site-specific remedial alternatives representing a range of technology types. Remedial alternatives for the Monsanto Plant are described and compared in Chapter 4. The range of alternatives assembled include a "no action" alternative, and alternatives that represent various levels of cleanup and/or protection.

This section is divided into three subsections. Section 3.1 provides estimates of the volumes and areas of media that contain elevated constituent concentrations. Section 3.2 describes the general response actions and technology types associated with each media and eliminates technology types that are not technically feasible at the Monsanto Plant. In Section 3.3 the various process options included within each retained technology type are briefly described and evaluated. The criteria for the evaluations include effectiveness, implementability, and cost. Section 3.3 also includes a general assessment of which process options are best suited for development of remedial alternatives in Section 4.

3.1 Estimated Volumes and Areas

The nature and extent of the constituent releases at the Monsanto Plant were characterized in the Phase I RI. These characterizations were used as the basis for determining the quantities of affected media for the Phase I FS. The assumptions and calculations for estimating media-specific quantities are discussed in the following sections. Table 3-1 summarizes the calculations for source materials, sediments, soils, and groundwater.

3.1.1 Source Material Quantities

Based on information gathered in the Phase I RI, there are five potential sources of constituent releases at the Monsanto Plant. The areas and tonnage of materials (and flow rate for the effluent) were estimated based on the dimensions of the stockpiles, or known volumes, if available, as described below.

The calcium silicate slag stockpile is located in the southwest portion of the Plant. Monsanto estimates that approximately 23 million tons of slag are stockpiled, and that approximately 700,000 tons of slag are produced per year. There are two baghouse dust stockpiles located in the northeast portion of the Plant with a total area of 13,000 square yards and an estimated total volume of 130,000 cubic yards. There are three underflow solids piles located in the north-northeast portion of the Plant, with an estimated total area of 150,000 square yards and total volume of 2 million cubic yards.

The coke and quartzite slurry pond located in the west-central portion of the Plant has an estimated area of 13,000 square yards. Assuming the depth of sediments in this pond to be approximately 10 feet, the quantity of material remaining in this pond is estimated to be 42,000 cubic yards.

The flow rate is used instead of a volume estimate for the non-contact cooling water effluent since it is a constantly-flowing source. Monsanto has estimated that the non-contact cooling water effluent discharge rate ranges from 600 to 1,200 gpm.

3.1.2 Sediment Quantities

The volume of sediments in Soda Creek that may be affected by constituent releases was estimated assuming that the stream bed has a constant 20-feet width. The thickness of potentially affected sediments was arbitrarily assumed to be 12 inches.

Elevated constituents were detected at both 100 feet and 300 feet from the point of discharge of the Plant non-contact cooling water effluent. The concentrations of the elevated constituents were lower at 300 feet than at 100 feet from the discharge point. Due to the lack of regulatory guidelines for sediments, the actual extent of sediments that may require remediation is unknown at this time. However, for illustration purposes the extent of potentially-affected sediments was arbitrarily determined to be 200 feet from the discharge point. Therefore, the potentially-affected area is estimated at 440 square yards and the volume of potentially-affected sediments is estimated at 150 cubic yards.

3.1.3 Soils Quantities

The extent of constituent releases to soils in the vicinity of the Monsanto Plant have not been adequately defined at this time since analytical data for soils were limited to the area just outside the perimeter of the site. For illustrative purposes, volume calculations provided in Table 3-1 assumed that the entire surface of the Monsanto Plant is potentially affected by constituent releases, plus an arbitrarily-determined perimeter of 1,000 feet outside the Plant boundaries. The thickness of potentially-affected soils was assumed to be 6 inches.

3.1.4 Groundwater Quantities

The groundwater plume areas and volumes were estimated based on data from the RI. The RI investigations indicated that groundwater containing elevated constituents occurs within the permeable fractured basalt and cinder zones of the UBZ and the LBZ.

Three UBZ groundwater plumes with significant elevated constituent concentrations are attributed to the Monsanto Plant: the UBZ-1 plume, the UBZ-2 plume, and the UBZ-4 plume. The UBZ-3 plume is attributed to Kerr-McGee. The cadmium plumes defined in the RI were determined to be representative of the constituents with low mobility, and are shown on Figure 3-1. Since chloride is a conservative tracer, the chloride plumes shown on Figure 3-2 were used to estimate the maximum plume extent in the UBZ. The areal extent of each cadmium and chloride plume shown in Table 3-1 was estimated based on the smallest contour value (0.01 mg/L for cadmium, and 50 mg/L for chloride). In some areas, contour locations are not well defined due to lack of data and the estimated areas should be considered approximate. The affected groundwater volumes, shown in Table 3-1, were calculated assuming plume thickness of 30 feet and a porosity of 20 percent.

In the LBZ, slightly elevated constituents are observed in monitoring wells screened in the LBZ-2 and LBZ-3 zones. The LBZ-3 plume is attributed to Kerr-McGee. Slightly elevated concentrations are also observed in some production wells screened across both the LBZ and UBZ, but are not considered representative of concentrations in the LBZ (see Section 1.4.4.3). The areas containing elevated concentrations of cadmium and chloride were not well defined in the Phase I RI due to minimal data in the LBZ. For illustrative purposes, the cadmium and chloride plume areas, in Table 3-1, were approximated by arbitrarily assigning the limits of these plumes; as shown in Figures 3-3 and 3-4, respectively. The volume of the LBZ-2 plume was estimated to range from 1.2×10^7 to 7.5×10^7 gallons (assuming a plume thickness of 30 feet and a porosity of 20 percent).

For strongly sorbed constituents, such as cadmium, a significant percentage of the constituent mass is associated with the solid matrix in the aquifer. As a result, multiple flushes of the aquifer will be necessary before the sorbed phase is removed from the aquifer. The amounts of groundwater pumped from the aquifer to remediate plumes of sorbed constituents will be greater than the volumes provided in Table 3-1.

3.2 General Response Actions and Technology Types

This section introduces general response actions, remedial technology types, and process options that may potentially satisfy one or more remedial objectives identified in Section 2. The range of response actions and technologies considered for the FS were derived from EPA guidance for RI/FS investigations (EPA 1988a), standard engineering texts, and experience at other sites. Technologies that clearly had no potential for satisfying remedial objectives (e.g., bioremediation, air stripping, vapor extraction, etc.) were eliminated from consideration and are not addressed. Tables 3-2 through 3-4 provide summaries of general response actions, remedial technology types, and process options for the three categories of impacted media: 1) solids (source materials, soils, and sediments), 2) groundwater, and 3) air.

After developing the list of general response actions, remedial technology types, and process options, each technology type was screened for general effectiveness and technical implementability. Determination of the effectiveness and technical implementability of a technology type was based upon the constituents of potential interest, the affected media, and the site-specific physical characteristics such as topography, geology, hydrogeology, and existing site development. The last column in Tables 3-2 through 3-4 indicate whether a technology type is retained or rejected for further consideration. The following subsections explain why certain technology types were rejected for each medium of interest.

3.2.1 Screening of Technology Types for Solids (Source Materials, Soils, and Sediments)

Table 3-2 indicates the technology types that rejected for remediation of source materials, soils, and sediments. The reasons for rejecting each technology type are provided below:

Vertical Barriers:

> The primary purpose of vertical barriers (such as slurry walls and injected grout walls) is to reduce horizontal migration of constituents of interest in the subsurface. Since the primary routes of migration for constituents of interest in source materials, soils, and sediments at the Monsanto Plant are windblown dust, surface water transport, and vertical infiltration, vertical barriers are not considered effective remedial measures for solids and are rejected from further consideration. In the saturated zone, with a significant horizontal component of groundwater flow, vertical barriers are more likely to be useful.

Thermal Stabilization:

The only thermal process options considered here is vitrification (or in-situ vitrification) whereby soil or waste is converted to glass at temperatures of 1350°C or higher. The process is initiated by a sending a large electrical current across electrodes that are inserted into the portion of soil affected by the constituents. This process converts the affected soil/waste into a chemically inert stable glass and crystalline product with the incorporation of non-volatile hazardous wastes components (such as heavy metals and radionuclides) (EPA 1985b).

Because of the high energy demands, vitrification is best suited for relatively small volumes of very hazardous materials that would be difficult to remediate with other means. Because chemically-affected solids at the Monsanto Plant are primarily large volumes and low concentrations, vitrification would be impractical. For this reason, and because vitrification is still an experimental technology, it was rejected from further consideration.

Encapsulation:

Encapsulation is the complete sealing or enclosure of a material in an impervious container or coating to minimize release of chemical constituents (EPA 1989). Encapsulation would require excavation of source material or soil and placement into steel drums, concrete vaults, or other containers. These containers would then require proper disposal or storage. Another encapsulation approach is to encase the excavated material in a resin for disposal or storage. Due to the large volumes of source materials and impacted soils at the Monsanto Plant, this technology type was rejected from further consideration.

In-Situ Fixation:

In-situ chemical fixation is the conversion of constituents to insoluble or strongly sorbed forms that will not leach from the disposal site. Metals such as lead, cadmium, zinc and mercury may be immobilized by chemical precipitation as sulfides with hydrogen sulfide gas or sodium sulfide solution (Manahan 1991). Significant problems with sulfide precipitation are that the soluble sulfide additives can be toxic and that it requires anaerobic conditions that are usually difficult to create in the subsurface. Another possible example of chemical fixation would be the oxidation of soluble metals to insoluble hydrous oxides. A disadvantage of this approach is that the metals may become remodilized when reducing conditions return. This technology is rejected for these reasons.

3.2.2 Screening of Technology Types for Groundwater

Table 3-3 indicates the technology types that were rejected for remediation of groundwater. The reasons for rejecting each technology type are provided below:

In-situ Chemical Extraction:

In-situ chemical leaching can be used to increase the recovery rate of insoluble or highly-sorbed constituents from the saturated zone. For example, sulfuric acid has been used for in-situ recovery of uranium from an ore body (Merritt 1971). The primary difficulty with this technology is locating a leaching agent that is both non-toxic and specific to the constituents of interest in the aquifer. Site specific research would be necessary to identify an appropriate leaching agent. A risk of this technology is that the leaching agent may mobilize a constituent that was previously not a groundwater problem. Given the wide range of constituents present in source materials, soils, and groundwater, chemical leaching is not well suited for groundwater remediation at the Monsanto Plant and will not be retained for further consideration.

In-situ Fixation:

In-situ fixation is rejected for the same reasons as described in Section 3.2.1 for solids.

3.2.3 Screening of Technology Types for Air

Table 3-4 lists the technology types for air. Since the only air emissions considered here are fugitive dust releases from inactive material stockpiles, the technology types for air are a subset of those considered for solids. No technology types were rejected for air.

3.3 Process Options

This section describes and evaluates process options included within technology types retained in Section 3.2. The purpose of the evaluation exercise is to identify the process options that are best suited for inclusion within remedial alternatives developed in Section 4. The evaluations are based upon three criteria discussed below:

Effectiveness:

The effectiveness of each process option was evaluated with regard to protection of human health and the environment. Evaluations were based on the ability of the process to treat the estimated area/volume of media and meet constituent reduction goals identified in the remedial action objectives. Consideration is also given to whether a process is proven and reliable with respect to the constituents and physical conditions at the site.

Implementability:

The implementability of process options encompasses both technical and institutional factors. Technical implementability may include site-specific chemical and hydrogeologic factors. For example, metals are not generally treatable with air stripping or biological degradation, and groundwater extraction trenches are difficult to install into rock or to great depths. Institutional implementability may include the ability to obtain necessary permits from government agencies, location- and action-specific ARAR compliance, and the availability of treatment, storage, and disposal facilities. Further consideration may include availability of necessary equipment and skilled personal to implement the technology.

Cost:

The cost factors for various process options have been considered on a relative basis within each technology type. Quoted costs from references older than five years have been corrected for inflation. Detailed cost estimates cannot be derived until the risk assessment is complete and specific concentration clean-up objectives have been established.

The subsections that follow describe the process options within each technology type considered for use and provide comparative evaluations with regards to these three criteria. This section is divided into subsections for each impacted media (solids, groundwater, and air). Note that some of the process options are applicable to more than one media.

3.3.1 Process Options for Solids (Source Materials, Soils, and Sediment)

The process options for source materials, soils, and sediments are described and evaluated in this section. Most of the process options are applicable to all three types of solid media. In cases where the process options would vary depending upon the media, these differences are identified and explained. A summary of the evaluations is provided in Table 3-5. Only those process options that were assessed as "average" or "good" are described below. For process options with an overall assessment of "poor", only the primary reason for the poor ranking is discussed.

3.3.1.1 No Action

No action is appropriate if the level of risk is below acceptable levels described in Chapter 2. If the level of risk is close to acceptable levels or is uncertain, it may be appropriate to monitor constituent concentrations in the transport media. Appropriate monitoring strategies could include measurements of constituent concentrations in 1) groundwater beneath the source material or impacted vadose zone soils, 2) air immediately downgradient of the source material or impacted soil, and 3) surface water downgradient of impacted sediments.

3.3.1.2 Access Restrictions

Access restrictions include two process options: fencing and deed restrictions.

Fencing

The perimeter of the Monsanto Plant is currently completely fenced and security is maintained by controlling and monitoring access to the Plant along the main access routes and through locked or guarded gates. The fencing is designed to prevent access to the site and to reduce the possibility of the general public coming into contact with anything that could be a hazard to their well being, including both chemical hazards and physical hazards (e.g., vehicle traffic, excavations, slope failure).

Deed Restrictions

Deed restrictions on land use would limit future use/actions occurring at the site. Examples of deed restrictions include prohibiting development for residential or agricultural purposes, and prohibiting excavation in certain areas that might pose a health hazard.

3.3.1.3 Covers

Covers generally involves covering source material or chemically-affected soil with a protective barrier to prevent direct exposure, limit infiltration, prevent transport of chemicals due to surface water run-off and fugitive dust, keep out burrowing animals, limit or control vegetation growth, and provide long-term stability with low maintenance requirements (EPA 1991a, Koerner 1990). Different cover materials may be used in conjunction with one another to achieve a more effective barrier.

Covers are particularity well suited for situations where extensive subsurface contamination, risk of hazard exposure, or prohibitive costs precludes excavation and removal of waste. Due to stream bed erosion, covers are not well suited for sediment remediation unless the stream is permanently diverted. The cover materials described in greater detail below include clay, synthetic membrane, asphalt/concrete, and slag.

Clay Covers

Clay covers are usually constructed with naturally-occurring clay or silt material compacted to a specified density range to reduce permeability and prevent the infiltration of water. Clay is commonly used for landfill covers and has been used at the Monsanto Plant for remediation of the underflow solids ponds. The cost of implementation is primarily dependant on the availability and cost of clay and the required cover thickness. Maintenance costs are generally relatively low.

Although clay covers are able to withstand minor amount of traffic under dry conditions, they can become significantly degraded by extensive traffic or minor amounts of traffic during wet conditions. Clay covers are commonly combined with native grass cover to reduce wind and water erosion. One problem with clay covers is that they are susceptible to cracking in arid climates. The significance of this problem at the Monsanto Plant is not known. Clay covers are difficult to build on steep slopes.

Synthetic Membrane Covers

Covers may be constructed with synthetic materials ranging in thickness from 20 to 100 mil. The material is deployed in sheets and welded together on site. In many cases synthetic membranes are placed over a clay cover. Synthetic membrane covers generally have a lower permeability than other liner materials and are very effective in reducing wind and water erosion. Because installation of synthetic membrane covers can be conducted without large equipment in the cover area, this material is very effective for steep slopes. Synthetic covers should not be subjected to vehicle traffic and may degrade due to weathering.

Asphalt or Concrete Cover

Asphalt or concrete covers utilize a layer of asphalt and/or concrete over a layer of crushed rock similar to a road surface. These materials are prefered over clay and synthetic materials for areas that will experience vehicle traffic. Although asphalt and concrete are resistant to weathering and erosion, they may crack due to heavy traffic, settling of the underlying material, and shrinkage. Fortunately, both asphalt and concrete are easy and inexpensive to repair. Asphalt is less expensive than concrete to install, although, the cost is dependant upon the thickness required.

Slag Covers

Molten slag from the furnaces in the Monsanto plant can be poured over a region with elevated constituent concentrations and allowed to harden to create a rock-like cover. A slag cover has already been installed over the underflow solids ponds. With an annual output of 700,000 tons (Golder 1991), slag could provide a readily available source of cover material. Advantages of slag are resistance to weathering and traffic and that it would be more difficult to inadvertently breach than other cover materials. Disadvantages of slag include safety problems associated with handling molten slag, difficulties with controlling surface slope to maintain proper drainage, the brittle nature of the material, and the untested effectiveness of slag covers.

3.3.1.4 Surface Controls

Surface controls are measures taken to reduce the degradation and/or loss of cover material by the actions of water, wind or human transport. These controls are generally applied to source materials and soils. Potentially applicable surface controls for source materials and soils include grading, vegetation, chemical stabilization, run-off diversion/collection, gravel armor and water application. Diversion and collection and gravel armor are the only process options that might be applicable for sediment remediation.

Grading

Grading is a general term describing the reshaping of the site surface in order to control surface-water infiltration and run off. General objectives include the elimination of ponding, minimizing soil erosion and preventing transportation of soil and/or constituents into surface water or groundwater. The application of grading will vary on a site-specific basis and is usually performed in conjunction with revegetation and capping. Grading is relatively inexpensive if materials are readily available, and if hauling, spreading and compacting are kept to a minimum.

Vegetation

Benefits from vegetation include: 1) increased evapotranspiration and reduced infiltration, 2) reduction of water and wind erosion, and 3) improved appearance. Vegetation is often planted after grading and/or installation of a clay cover to reduce infiltration and erosion. In most situations, it will be necessary to place a layer of topsoil to provide suitable soil conditions for vegetation to survive. Native grasses and plants are preferred for surface control because of their ability to survive weather extremes common to the area. Vegetation is generally relatively inexpensive.

Water Application

Water application by tanker truck is commonly utilized at construction and mining sites to minimize dust generation. Although this strategy may be useful on a short term basis or for material handling, it is unsuitable for long term use, primarily due to the opportunity for increased infiltration and runoff.

Chemical Stabilization

Chemical stabilization relies on polymers products, such as Coherex, to bind up surface soil materials. Generally, the polymers react with surface materials to produce products that are less volatile, less soluble, and less reactive. This process may also be used to transform wastes into a form suitable for long-term disposal. Chemical stabilization is more expensive than water application (Manahan 1991), but generally provides longer-term dust suppression without increasing infiltration rates. Environmental impacts of the polymers should be carefully considered before application.

Gravel Armor

A layer of coarse-grained material, refered to as gravel armor, can be used to reduce water and wind erosion and for dust control. This is a relatively inexpensive process to implement and provides a more permanent solution than water application without the environmental concerns of chemical stabilization. Crushed slag could be used as gravel armor.

Run-off Diversion and/or Collection

Run-off diversion and/or collection includes site grading to capture surface run-off, and retention facilities to slow the water velocity or temporarily store the run-off. The retention facility allows suspended solids to settle out and may provide an opportunity to sample the water before it is released. Diversions can be made by grading the surface and installing weirs to collect the directed water. The overall procedure for installing diversions is relatively simple and inexpensive, but would require continued maintenance for long-term effectiveness.

3.3.1.5 Grouting

Waste grouting has been used to decrease infiltration and reduce leaching from soils and source materials. The grout may be mixed or injected into the source material or soil using a variety of methods. Shallow materials are often stabilized by tilling cement into the upper surface. Large augers have been used to mix cement to greater depths. Although grout injection is frequently used in geotechnical applications for increasing soil and rock strength and decreasing permeability, it is less useful for stabilization of chemically affected materials because of inconsistent grout distribution. Incomplete mixing is a problem with all in-situ mixing approaches. Better mixing can usually be achieved by excavating the material of interest and mixing it with the grout above ground, such as on an asphalt pad using earth moving equipment or in a cement mixer.

Grouting has also been used to stabilize hazardous waste from industrial processes, including plating wastes, oil sludges, waste acids, and creosote (EPA 1989). Grout injection can also be used to create a hydraulic barrier in the saturated zone; this application will be discussed in Section 3.3.2 for groundwater.

Various materials have been used for grouting, including Portland cement, bentonite/cement mixtures, pozzolanic agents, and chemical polymers. Portland cement is a mixture of calcium and aluminum silicates and lime that hardens when mixed with water. In many cases, bentonite is added to the cement to decrease permeability. Pozzolanic agents are silicate and alumino-silicate substances such as fly ash, pumice, lime, kiln dusts, blast furnace slag or diatomaceous earth which react with lime in the presence of water to form a cement-like matrix. Compared with cement, pozzolanic agents are less subject to sulfate degradation and calcium hydroxide leaching. Pozzolanic agents also require less water and usually cost less than Portland cement. The disadvantages of pozzolanic agents include a higher shrinkage factor and a slower hardening time (Troxwell and Davis 1956, and EPA 1989). The cost of fly ash is estimated as up to $40 per ton, while cement costs in the neighborhood of $50 per ton (Towers et al. 1989).

3.3.1.6 Excavation

Excavation to support environmental restoration may be conducted to move a hazardous material to a safer location (such as a landfill) or to facilitate aboveground treatment. Due to liability concerns and public perception, treatment and hazard reduction solutions are preferred over landfilling. Therefore, excavation and disposal would be limited to small volumes of material that are difficult or costly to treat. Section 3.3.1.7 discusses several disposal options, while Sections 3.3.1.8 through 3.3.1.10 describe a number of treatment options for treating solid materials.

3.3.1.7 Solids Disposal

Excavated solid materials will ultimately require disposal. Three disposal process options are discussed below: landfill, clean fill, and recycling. Which of these options is utilized will depend upon the characteristics of the excavated material and the availability of receiving facilities.

Landfill

Landfilling is unlikely to be implemented except on a limited basis for small quantities of waste, as has been done for sanitary waste at the permitted landfill in the are off-site a of the former northwest pond. No hazardous or processing wastes are disposed in the northwest pond landfill. For large volumes of waste, the cost of transportation and disposal may be prohibitive, and on-site treatment or containment are generally considerably cheaper to implement. Additionally, there are growing complications and cost associated with regulatory control of hazardous waste movement, transport and disposal.

Clean Fill

If excavated material is treated such that the associated risk is acceptable, it may be possible to place the material as clean fill. Using treated material as clean fill may include fulfilling an actual filling need, placing material back in the excavation it came from, or simply stockpiling the material in a suitable location. Although off-site utilization of clean material is theoretically possible, on-site placement is more feasible considering liability concerns and potential difficulties locating a receptive off-site receiver.

Recycling

Recycling of metal-bearing source material and soils may be useful if specific metals are easily isolated and separated, and if the concentrations are high enough. An illustration of effective recycling is the sale of ferrophosphorus slag produced by Monsanto to Kerr-McGee for vanadium extraction.

3.3.1.8 Washing

This section addresses above-ground washing of solids to remove hazardous constituents. Two process options, water processing and chemical extraction, are discussed below. A wide variety of configurations are utilized for material washing facilities and only the general procedures are described below. The costs for material washing are highly variable and depend upon the constituents of interest, grain-size distribution, and constituent reduction goals.

Water Washing

A material-washing facility utilizing water as the solvent may contain screens, sprayers, cyclones, and other equipment. The material for remediation must first be excavated and loaded into the facility for washing. The washing process separates the material into two streams: a slurry stream containing most of the fines and constituents of potential interest, and a relatively clean coarse-fraction stream. Water washing concentrates constituents into the slurry in two ways. Some of the chemicals are dissolved off the solid particles into the liquid solvent. In addition, because of the large surface area associated with finer particles, sorbed constituents are concentrated in the slurry with the fine fraction and the coarse fraction is relatively clean. Constituent concentrations in the coarse fraction can be reduced from one to two orders of magnitude. The amount of slurry produced depends upon the distribution of grain sizes in the material and the concentration reduction goals. Greater concentration reduction in the coarse fraction results in greater slurry production. This trade-off is very important considering that additional treatment or disposal is required for the slurry.

Chemical Extraction

Chemical extraction consists of the same basic process as stated for water flushing except that the solvent solution can be an acid base, an organic solvent, a surfactant, a reducing agent, a complexing agent, or a chelating agent. This process has been used for the removal of hydrophobic (non-water soluble) organics and heavy metals to achieve better treatment efficiencies than with water washing alone. The primary disadvantage of chemical extraction over water washing is that the resulting sludge may be more difficult to treat and/or dispose.

Chemicals that have been used for extraction of metals include: diluted acid solutions to dissolve metals such as cadmium, chromium, copper, lead, and nickel into solution, chelating agents such as ethylenedinitrilotetraacetate (EDTA) to form soluble metal species, and reducing agents such as sodium dithionate/citrate or hydroxylamine to dissolve metal oxides (Manahan 1991). Note that one process may not be applicable to all of the constituents of potential interest.

3.3.1.9 Dewatering

Dewatering may be necessary for treatment of sludges from material washing facilities or water treatment facilities. Considering the potential constituents of interest at the Monsanto Plant, these sludges would likely have elevated concentrations of heavy metals such as cadmium. Potential reasons for dewatering a sludge or solid include: volume reduction, improved handling characteristics, facilitation of further treatment compliance with disposal requirements that prohibit free liquids. Dewatering process options include filter press, belt filter press, vacuum filtration, and dewatering beds.

Filter Press

A filter press is a batch-dewatering process whereby sludge is strained through a filter of either cloth, polypropylene or wire mesh. The solids are retained on the filter and the liquid passes through. When the flow rate slows due to a buildup of solids the inflow is stopped and the solids are compressed to produce a dry sludge cake. The advantages of using this process are a very high cake solids content, good filtrate clarity, simplicity and flexibility, the ability to operate at high pressures, and relatively low cost.

Belt Filter Press

The belt filter press is a continuous dewatering process that utilizes cake formation under gravity followed by dewatering by mechanical compression between two moving belts. Belt filters have been used mainly for dewatering of sludge resulting from flocculation of biological treatment plant effluent. The reliability of the belt filter press is similar to the filter press. Advantages of the belt filter press over the filter press are the continuous nature of the process and lower labor and power costs. The cake-solids content is less than from a filter press but greater than from a vacuum filter. There is currently a belt filter press in operation on the Monsanto Plant to dewater solids from the hydroclarifier (Golder 1991), but additional capacity is limited.

Vacuum Filtration

Vacuum filters rely upon a vacuum instead of a mechanical press to remove liquid from the cake solids. The vacuum may be applied against a drum, coil, continuous disk, or belt. The advantage of this process is that it is a continuous process with low labor requirements and low maintenance and labor costs. The disadvantages in comparison with filter press approaches are high energy consumption, relatively constant effluent rates are required, and the need for high cost pumps to maintain the vacuum (Hammer 1986 and EPA 1991b). In addition, vacuum filtration produces a low cake solids content, it is seldom possible to dewater an inorganic slurry to more than 70% solids and a biological sludge to more than 20% solids level (Kemmer 1988).

Dewatering Beds

Dewatering beds are ranked as poor because they would be ineffective during cold or wet weather.

3.3.1.10 <u>In-Situ Flushing</u>

In-situ flushing, including water flushing and chemical extraction, was given a poor ranking because it would induce migration of the constituents of potential interest through the vadose zone into groundwater, thereby extending the volume of affected media.

3.3.2 Process Options for Groundwater

The process options for groundwater are described in this section. Evaluations are summarized in Table 3-6.

3.3.2.1 <u>No Action</u>

No action is appropriate if the level of risk is below acceptable levels described in Chapter 2. If the level of risk is close to acceptable levels or is uncertain, it may be appropriate to monitor constituent concentrations in groundwater to confirm that the levels of risk remain below acceptable levels.

3.3.2.2 Access Restrictions

The only identified access restriction effective for controlling exposure to groundwater is deed restrictions.

Deed Restrictions

The potential for human exposure could be reduced by placing deed restrictions that prohibit groundwater use at the site. These restrictions would not protect against impacts from groundwater use downgradient of the site. Furthermore, although such restrictions would be useful in the short term while Monsanto owned the property, compliance would become less likely as time passed, particularly if the land changed ownership many times.

3.3.2.3 Alternative Water Supply

Alternative water supplies could be provided to residents downgradient of the site who rely upon groundwater. The only nearby well that is downgradient of the site is the Lewis Well.

3.3.2.4 Vertical Barriers

The primary objectives of vertical barriers are to minimize horizontal migration of constituents in the saturated zone and/or lower the pumping rates necessary to provide hydraulic capture of a groundwater plume. The hydraulic barriers discussed below include slurry walls, sheet pilings, grout injection, and in-situ filtration.

Slurry Walls

Slurry walls were given a poor ranking because installation into the basalt underlying the Monsanto Plant would be difficult or impossible.

Sheet Piling

Sheet piling was given a poor ranking because it could not be installed into the basalt underlying the Monsanto Plant.

Injected Grout Curtain

Subsurface grout curtains are installed by injecting grout into a soil or rock mass. The grout curtain serves to reduce permeability and/or impart increased soil strength and stabilization. Either cement grout or chemical grouts (generally silica or aluminum-based polymers or solutions) may be used. Because the majority of groundwater flow occurs in relatively thin interbed zones within the basalt, a grout curtain could be installed across just the interbed regions. The major problem with grout curtains, however, is the potential for gaps in the grout barrier.

In-Situ Filtration

In-situ filtration was given a poor ranking because it is a relatively untested technology and because of installation difficulties into basalt.

3.3.2.5 Groundwater Extraction

The purposes of groundwater extraction are to remove chemical-bearing groundwater from the subsurface for treatment and to limit migration of chemical-bearing groundwater in the subsurface. Methods for groundwater extraction include vertical wells, horizontal wells and interceptor trenches.

Vertical Wells

Pumping from vertical wells is the most common means of groundwater extraction and drilling and installation of vertical wells is a well-developed technology. Steep drawdown cones may develop in low permeability sediments requiring close spacing of wells, however, and multiple wells may be necessary to completely capture a groundwater plume.

Horizontal Wells

The technology for drilling and installing horizontal groundwater wells is still in the development stages. Because pumping from a horizontal well results in primarily parallel flow, drawdowns are much less than for comparable pumping rates in vertical wells. As a result, the number of horizontal wells required to capture a groundwater plume in a thin water-table aquifer could be significantly less than the number of vertical wells. The cost advantage of horizontal wells over vertical wells depends upon the hydrogeologic characteristics of the site (e.g., depth to groundwater, hydraulic conductivity, aquifer thickness, plume width, and soil/rock type).

Interceptor Trenches

Interceptor trenches were given a poor ranking because installation into basalt would be difficult or impossible.

3.3.2.6 Physical Treatment

Physical treatments described below include coagulation, flocculation, adsorption, filtration, evaporation, freeze crystallization, and reverse osmosis.

Sedimentation

Sedimentation relies upon gravity settling to remove suspended solids from liquid effluent. Since the constituents of interest at the Monsanto Plant are primarily dissolved constituents, sedimentation would only be appropriate following a precipitation stage.

Sedimentation is typically conducted in a clarification basin or tank with a slow water velocity and scrapers or raking arms to remove accumulated sludge.

Coagulation/Flocculation

Coagulation/flocculation is used to enhance separation of suspended solids from water when natural settling rates are too slow for sedimentation. Coagulation chemicals are usually low molecular weight binders, such as aluminum and iron salts or alum (hydrated aluminum sulfate), that are typically added to water with high speed mixing to destabilize suspended or colloidal solids and cause them to form floc.

Flocculation chemicals can improve the efficiency of the coagulation process by increasing or decreasing the floc size. Common flocculation agents are weighting agents such as bentonite clays, adsorbents such as activated carbon, oxidants such as chlorine, ozone, and potassium permanaganate, and organic polymers. Coagulation/flocculation could be useful for groundwater treatment as an intermediate process between precipitation and sedimentation.

Carbon Adsorption

Carbon adsorption was given a poor ranking because it is not very effective for most of the constituents of potential interest at the Monsanto Plant.

Filtration

Filtration is used to separate particles from a solvent (usually water) through the use of a porous medium. Flow through the filter medium can be induced through gravity, applied pressure, applied vacuum, or centrifical means. The most common filtration medium is sand, although carbon or synthetic materials may be used. The filter material usually requires periodic replacement or backwashing, resulting in a concentrated waste stream that may require disposal or additional treatment.

Evaporation

Evaporation involves addition of heat to a solution, slurry, or sludge such that the water is driven off by vaporization. This process is generally conducted to reduce the volume of waste material and provide a more manageable waste. Evaporation is a well-defined and established process used in the treatment of hazardous waste, radioactive liquids and sludges, metal-plating wastes and organic/inorganic wastes. Evaporators may consist of boilers that rely upon man-made heat, or large evaporation ponds that rely upon solar evaporation. Boiler operation is expensive, while solar evaporation is cheaper but requires large evaporation ponds or basins and is ineffective in cold or wet weather.

Freeze Crystallization

Freeze crystallization was given a poor ranking because it is relatively untested and expensive (due to high energy requirements).

Reverse Osmosis

Reverse osmosis relies upon a pressure application on the influent stream that induces relatively pure solvent migration across an osmotic membrane, leaving behind a higher concentration solution. The membrane usually consists of a non-ionic organic polymers. Process efficiency can be increased (up to a point) by increasing the pressure differential. Depending on the concentration differential across the membrane, up to 98% concentration reduction in total dissolved solids is possible. Reverse osmosis has low space and energy requirements, can be fully automated, and is well-suited for small scale operations.

One disadvantage of reverse osmosis is fouling of the membrane by high molecular-weight species. Pre-treatment, such as pH adjustment, removal of calcium and magnesium ions by softening, or filtration, is often required to minimize problems with membrane fouling.

3.3.2.7 Chemical Treatment

Chemical treatments discussed below include precipitation, ion-exchange, oxidation/reduction, electrolysis, electrodialysis, and solvent extraction.

Precipitation

Precipitation consists of the conversion of a soluble substance to an insoluble form, usually by changing the chemical composition of the solution. Precipitation is commonly used in water-treatment plants to reduce water hardness and/or remove metal ions. It is also used to remove metallic ions (such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc) from industrial waste waters. Common chemicals used for waste water precipitation include; lime, alum, ferrous sulfate, ferric chloride, ferric sulfate, hydrogen sulfide, and magnesium chloride. Sulfide precipitation is currently used at the Monsanto Plant to reduce cadmium concentrations in the hydroclarifier. Precipitation is commonly combined with sedimentation and/or filtration and is a relatively inexpensive, well developed process.

Ion-exchange

Ion-exchange involves the reversible exchange of ions between solution and a solid ion-exchange material. The ion exchanger releases the exchanged ions to absorb ions for which it has a greater affinity. For example, sodium may be released in favor of calcium, magnesium, iron, manganese and strontium ions. Ion exchangers can be used until their respective exchange capacities are reached and they fail to accept additional ions. A regeneration solution with a high concentration of exchange ions is then required to displace constituent ions and regenerate the exchanged resins.

Exchange resins fall into two categories, cationic and anionic. Cation resins can remove cation soluble metal species; whereas anion resins remove acids, such as anionic cyanide metal complexes. Due to the charge differences, these two exchange resins operate in different pH ranges. To a limited extent, ion exchange systems can be designed to remove specific constituents by variations in resin material, exchange ion, and pH. For example, ion exchange using activated alumina is probably the most effective method for reducing fluoride levels. Ion exchange resins have also been developed for removal of ammonium from solution. Ion exchange is often used as a polishing step for either reverse osmosis or electrodialysis, is well suited for small-scale systems, and produces a high-quality effluent.

Oxidation/Reduction

Oxidation/reduction was given a poor ranking because it is not effective for the constituents of interest at the Monsanto Plant.

Electrolysis

Electrolysis relies upon application of a current across electrodes to cause precipitation of cations at the cathode and anions at the anode. Electrolysis is used for removal and recovery of heavy metals, including cadmium, arsenic, nickel, and zinc.

Electrodialysis

Electrodialysis involves the application of an electrical potential across a semi-permeable ion exchange membrane such that it becomes a charged membrane with anion/cation exchange properties. This process is used to remove or concentrate ionic species from solution with a parallel array of solution compartments that induce ion migration in solution. The process produces a treated permeate with decreased ion concentrations and a concentrated effluent requiring further treatment.

Inorganic and metal ions can be removed from wastewaters with TDS concentrations below 5,000 mg/L. As the dissolved solids concentration increases, there is an increase in required membrane area, and energy consumption will increase proportionately. Electrodialysis may be able to produce a concentrated stream ten times the concentration produced by reverse osmosis, but the permeate will not be as pure. A disadvantage to using electrodialysis is that the membrane is sensitive to fouling by large organic ions, colloids and microbial growth (Freeman 1989 and Manahan 1991).

3.3.2.8 Biological Treatment

Nitrification/Denitrification

Nitrification/denitrification is generally a two-step process whereby ammonia is oxidized to nitrate (nitrification) and nitrate is converted to nitrogen gas (denitrification). Both steps in the process are necessary to remove the ammonium ion. Nitrate removal can be achieved with just the denitrification step.

Bio-Fix Beads

Biofixation using bio-fix beads is the only biological treatment identified with potential application for removal of metals from solution at this facility. Treatment with bio-fix beads was given a poor ranking because it is relatively untested.

3.3.2.9 Surface Disposal

Three surface disposal methods for treated wastewaters have been identified, including the sanitary sewer system, surface water, and re-use.

Sanitary-Sewer System

Sanitary-sewer systems are intended to carry liquid and water wastes from residences, commercial buildings, industrial plants and institutions. Discharging of waters to a sanitary system may be implemented with on-site pretreatment prior to release, and with proper permitting (King 1989). The City of Soda Springs has some limited excess capacity in their treatment system. The availability of this capacity, and the effluent limitations, are currently unknown.

Surface-Water Disposal

Soda Creek is the nearest candidate surface-water body that could receive treated effluent. Discharge of cooling-water effluent from the Monsanto Plant to Soda Creek is currently regulated by an NPDES permit. The permit would require modification to allow addition of new treated groundwater streams to the discharge.

Re-Use

Treated groundwater could be used to replace process water used in the Monsanto Plant. Although such use could help reduce pumping and treatment costs for process waters, ultimate disposal after use is still necessary.

3.3.2.10 Subsurface Disposal

Subsurface disposal options include shallow infiltration trenches and infiltration ponds.

Shallow Infiltration Trench

A shallow infiltration trench can be used for disposal of treated effluents. Generally trenches are simple to construct and may incur less operation and maintenance costs than injection wells. Since infiltration trenches sometimes qualify as deep injection wells, as described above, permitting under the underground injection program will be necessary. Effluent requirements are likely to be similar to NPDES requirements since no degradation of usuable groundwater is allowed. Compared with an infiltration pond (which receives wind-blown sediment), an infiltration trench generally requires less maintenance; but if the filter material or surrounding formation become clogged the trench may become ineffective. Infiltration trenches generally require less space than infiltration ponds.

Infiltration Pond

An infiltration pond can be used for disposal of treated effluents. Effluent requirements are likely to be similar to NPDES requirements as described above for infiltration trenches, since no degradation of groundwater is allowed. Due to wind-blown sedimentation, an infiltration pond generally clogs faster than an infiltration trench, but can be easily remediated by drying and scraping. Infiltration ponds can require large areas to provide sufficient infiltration capacity.

3.3.3 Process Options for Air

Process options for air are described in this section. Evaluations for air-related process options are summarized in Table 3-7.

3.3.3.1 No Action

No action is appropriate if the level of risk is below acceptable levels described in Section 2. If the level of risk is close to acceptable levels or is uncertain, it may be appropriate to monitor constituent concentrations in air to confirm that the level of risk remains below acceptable levels.

3.3.3.2 Access Restrictions

Process options that qualify as access restrictions for air are the same as those for solids: fencing and deed restrictions. The primary purpose of these access restrictions with regards to air, however, is to reduce exposure to airborne constituents. Because airborne constituents are easily transported across property boundaries, access restrictions are less effective for air than solids.

Fencing

Fencing was described in Section 3.3.1.2.

Deed Restrictions

Deed restrictions were described in Section 3.3.1.2.

3.3.3.3 Covers

The primary purpose of covers with regards to constituent releases in air is to prevent airborne transport of fugitive dust. Descriptions of cover materials were provided in Section 3.3.1.3 for solids, and will not be repeated in this section. Since the remedial objectives are different for airborne releases than solids, different evaluations are provided in Table 3-7.

3.3.3.4 Surface Controls

The primary purpose of surface controls with regards to constituent releases in air is to prevent airborne transport of fugitive dust. Descriptions of surface controls were provided in Section 3.3.1.4 for solids, and will not be repeated in this section. Since the objectives are different for airborne releases than solids, different evaluations are provided in Table 3-7. Diversion/collection was given a poor ranking because it is not effective for reducing fugitive dust.

4. DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

In the prior section, remedial technologies types and process options that are potentially applicable to the Monsanto Plant were introduced and screened. Only general criteria, such as effectiveness in achieving preliminary remedial action objectives, technical and institutional implementability, and relative cost, were considered in the initial review. In this section, process options are combined into remedial alternatives that address all the remedial action objectives. The remedial alternatives are intended to represent the range of most likely treatment and containment combinations. Additional site information and possible treatability studies are suggested for each remedial alternative. Once the risk assessment is performed and remedial action objectives are refined, several of the most appropriate alternatives will be selected for more detailed analysis during the next phase of the FS.

Remedial alternatives are developed for all the media identified in the RI that had constituent concentrations that could potentially exceed acceptable levels of risk. These media include: source materials, soils, sediments, groundwater, and air. Constituent concentrations in surface water did not exceed risk-screening levels.

4.1 Development of Alternatives for Source Materials

Potential source materials were described in Section 1.4. Five potential source areas have been identified, in the RI, including:

- Calcium silicate slag piles
- Baghouse dust
- Underflow solids
- Coke and quartzite dust slurry ponds
- Non-contact cooling water effluent

The non-contact cooling water effluent is a liquid effluent currently discharged to Soda Creek under an NPDES permit. Since this effluent is within regulatory compliance, development of remedial alternatives is not necessary. The remainder of the potential source materials are solids and may be considered for remediation. The constituents of potential interest for these materials have not been identified. Transport and exposure pathways that may result in unacceptable risk include: 1) direct exposure, 2) ingestion, 3) inhalation of fugitive dust, and 4) infiltration to groundwater. Seven remedial alternatives have been developed to address potential risks associated with these pathways.

Five remedial alternatives for source materials are described below. The RI/FS guidance (EPA 1988a) suggests that development of a full range of treatment alternatives for sites with large volumes of low-concentration materials may prove impractical due to technological limitations, or extreme costs. It is likely that a number of the alternatives described below will be impractical or cost-prohibitive given the large waste volumes at the Monsanto Plant.

4.1.1 Alternative SM-1: No Action

Other than some possible monitoring of air and groundwater concentrations, the no-action alternative requires no systems. This alternative is most appropriate for source materials that have associated risk levels less than acceptable standards. No action may also be appropriate if all candidate remedial actions would result in either: 1) significant environmental damage, 2) great risk to human health, or 3) excessive cost, as compared to the level of risk reduction. For example, even if the risk associated with fugitive dust emissions from the slag piles exceeds allowable levels, the cost required to treat 25 million tons of material may not warrant remediation.

4.1.2 Alternative SM-2: Access Restrictions

The elements included within this alternative are:

- Deed restrictions
- Fencing

The primary purpose of these access restrictions would be to minimize the potential for people to come within close proximity of the source material. This alternative would be appropriate if the constituents of potential interest in the source material are relatively immobile and the primary pathway of risk is direct exposure.

4.1.3 Alternative SM-3: Surface Controls, Containment, and Access Restrictions

The elements included within this alternative are:

- Grading
- Clay cover
- Vegetation
- Deed restrictions
- Fencing

Containment and access restrictions would be appropriate if significant levels of risk are associated with fugitive dust and/or infiltration. Grading would be conducted before construction of the clay cover to minimize slopes, eliminate hollows, and prepare a smooth upper surface. The clay cover would provide protection against dust generation and reduce infiltration. Vegetation would be planted over the clay cover to increase evapotranspiration and stabilize the clay surface against wind and water erosion. The purpose of the access restrictions would be to minimize potential disturbance of the cover.

4.1.4 Alternative SM-4: Removal and Disposal

The elements of this alternative include:

- Excavation
- Landfill disposal

This remedial alternative could be appropriate if non-intrusive alternatives, such as containment, are deemed insufficient or too difficult to implement. The primary advantage of this remedial alternative is that it results in elimination of the constituents of potential interest from the Plant. However, disposal in a landfill is generally relatively expensive and may be infeasible for large amounts of material. As a result, this alternative is best suited for small amounts of particularly hazardous source material.

4.1.5 Alternative SM-5: Removal, Treatment, and Disposal

The elements of this alternative include:

- Excavation
- Water washing
- On-site fill of clean coarse material
- Belt filter press of constituent-enriched slurry
- Landfill disposal of solids from slurry
- Treatment of liquid effluent from slurry using precipitation/filtration
- Process filter backwash through the belt filter
- Re-use of treated liquid effluent in washing operation.

The ultimate goal of this treatment approach is to concentrate the constituents of potential interest in the source material into the smallest volume possible to minimize landfilling costs. After excavation, treatment begins with water washing the material, thereby removing the fines and most of the constituents of potential interest from the coarser material. The coarse material should be clean enough at this stage to allow placement as clean fill back in the excavation. The slurry produced by the water washing should now contain most of the constituents of potential interest and the fine-grained portion of the source material. The solids are removed from the liquid by a belt filter press to facilitate landfilling of the solids. The resulting liquid effluent can be treated using precipitation and filtration before re-use in the water washing operation. The filter backwash would be processed through the belt filter to remove the precipitate.

The percentage volume reduction by this process will depend upon the geochemical properties of the constituents of potential interest, the required amount of concentration reduction, and the properties of the source material. Treatability studies would be necessary to design the treatment system. This remedial alternative may be necessary if non-intrusive alternatives, such as containment, are deemed insufficient. Because of the high cost of this alternative it is best suited for small quantities of material.

4.2 Development of Alternatives for Soils

Shallow soils with elevated constituents of potential interest appear to be widespread, potentially affecting both on-site and off-site regions. The constituents of potential interest for these soils were identified in Subsection 1.4.2, and include arsenic, beryllium, cadmium, manganese, lead-210, polonium-210, radium-226, thorium-230, and uranium. Transport and exposure pathways that may result in unacceptable risk include: 1) direct exposure, 2) ingestion, 3) uptake in crops and livestock, 4) inhalation of fugitive dust, and 5) infiltration to groundwater.

Six remedial alternatives have been developed to address potential risks associated with these soil pathways. These alternatives are similar to those developed for source materials in the previous sections.

4.2.1 Alternative SOIL-1: No Action

Other than some possible monitoring of constituent concentrations in vegetation and livestock, the no-action alternative requires no systems. This alternative is most appropriate for soils that have associated risk levels less than acceptable standards. No action may also be appropriate if all candidate remedial actions would result in either: 1) significant environmental damage, 2) great risk to human health, or 3) excessive cost, as compared to the level of risk reduction. For example, containment, removal, or treatment of the upper six inches of soil for hundreds of surrounding acres could result in significant environmental harm that may not be warranted given the amount of risk associated with the soils.

4.2.2 Alternative SOIL-2: Access Restrictions

The elements included within this alternative are:

- Deed restrictions
- Fencing

The primary purpose of these access restrictions would be to minimize the potential for direct contact with the affected soils, as well as prohibit growing of crops or grazing livestock on the affect soils. This alternative would be appropriate if the primary pathways of risk are direct exposure and biota uptake.

4.2.3 Alternative SOIL-3: Surface Control, Containment, and Access Restrictions

The elements included within this alternative are:

- Grading

- Asphalt cover
- Deed restrictions
- Fencing

Surface control, containment, and access restrictions are appropriate if significant levels of risk are associated with fugitive dust and/or infiltration. Grading would be conducted before construction of the asphalt cover to minimize slopes, eliminate hollows, and prepare a smooth upper soil surface. The asphalt cover would provide protection against dust generation and reduce infiltration. The purpose of the access restrictions would be to minimize potential disturbance of the asphalt cover.

4.2.4 Alternative SOIL-4: Stabilization, Surface Controls, and Access Restrictions

The elements included within this alternative are:

- Cement/bentonite grouting
- Vegetation
- Deed restrictions
- Fencing

Dry cement/bentonite grout would be mixed into the affected soils using a disker or other means. The percentage of grout in the soil would be based upon bench and pilot tests to determine the amount required to provide sufficient decrease in leachability of constituents. After mixing was complete, water would be applied to the surface to initiate setting of the grout. Topsoil and vegetation would be placed over the grouted soil to improve appearance of the area and reduce infiltration. Alternatively, the area could be used for stockpiling of material. This alternative could provide permanent remediation without excavation and off-site disposal. Access restrictions would be intended to reduce the potential for direct exposure to the constituents of potential interest.

4.2.5 Alternative SOIL-5: Removal and Disposal

The elements of this alternative include:

- Excavation
- Landfill disposal

This remedial alternative is identical to the alternative for source materials discussed in Section 4.1.4.

4.2.6 Alternative SOIL-6: Removal, Treatment and Disposal

The elements of this alternative include:

- Excavation
- Water washing
- On-site fill of clean coarse material
- Belt filter press of constituent-enriched slurry
- Landfill disposal of solids from slurry
- Treatment of liquid effluent from slurry using precipitation/filtration
- Process filter backwash through the belt filter
- Re-use of treated liquid effluent in washing operation.

This remedial alternative is identical to the alternative for source materials discussed in Section 4.1.5.

4.3 Development of Alternatives for Sediments

Elevated constituent levels have been identified in Soda Creek sediments downstream of the effluent discharge point for the process cooling water. Elevated constituents of potential interest include cadmium, copper, nickel, polonium-210, selenium, silver, and vanadium. Exposure pathways of interest for Soda Creek sediments include: 1) direct exposure, 2) ingestion, and 3) uptake in crops irrigated with waters from Soda Creek and cattle fed on irrigated crops. Four remediation alternatives to address these pathways are considered in the following sections.

4.3.1 Alternative SED-1: No Action

Other than some possible monitoring of surface-water concentrations, the no-action alternative requires no systems. This alternative is most appropriate for sediments that have associated risk levels less than acceptable standards. No action may also be appropriate if all candidate remedial actions would result in either: 1) significant environmental damage, 2) great risk to human health, or 3) excessive cost, as compared to the level of risk reduction. For example, disruption of the stream bed to remediate elevated concentrations of constituents of potential interest could result in greater environmental harm than benefit.

4.3.2 Alternative SED-2: Surface Controls and Stabilization

The elements of this remedial alternative are:

- Collection and diversion system for Soda Creek
- Cement/bentonite grouting of sediments
- Vegetation.

This alternative includes construction of a collection and diversion system that would permanantly route the waters of Soda Creek around the region of affected sediments and stabilization of the sediments using a cement/bentonite grout. The diversion/collection system would include a dam to allow collection of the streamflow and a pipeline, canal, or new streambed parallel to the affected region of the stream to transport the water. The water could be discharged to the irrigation canal that intersects Soda Creek approximately 100 feet downstream of the effluent discharge location. Such a system would clearly result in some disruption of the natural stream system. The grout stabilization would be conducted in the sections of streambed with effected sediments in the same manner as described in Section 4.2.4 for soils. Topsoil and vegetation would be placed over the grouted material to improve appearance and reduce infiltration.

4.3.3 Alternative SED-3: Removal and Disposal

The elements of this remedial alternative include:

- Temporary diversion/collection
- Excavation
- Landfill disposal.

A temporary diversion and collection system, similar to that discussed in the previous section, would be constructed to dewater the creek and allow the sediments to dry out. The affected sediments would then be excavated and disposed in a landfill.

4.3.4 Alternative SED-4: Removal, Treatment, and Disposal

The elements included in this remedial alternative include:

- Temporary diversion/collection
- Excavation
- Water washing
- Replace clean coarse material in stream bed
- Belt filter press of constituent-enriched slurry
- Landfill disposal of solids from slurry
- Treatment of liquid effluent from slurry using precipitation/filtration
- Process filter backwash through the belt filter
- Re-use of treated liquid effluent in washing operation.

This alternative is essentially the same as Alternatives SM-5 and SOIL-6, except that diversion/collection of the streamflow is required to dry out the sediments.

4.4 Development of Alternatives for Groundwater

Elevated constituent concentrations have been identified in several groundwater plumes beneath the Monsanto Plant. Constituents of potential interest include arsenic, cadmium, nickel, zinc, selenium, ammonium, fluoride, nitrate/nitrite, and radium-226. The exposure pathway of interest for groundwater is ingestion of groundwater from the Lewis Well. Four remediation alternatives are considered in the following sections.

4.4.1 Alternative GW-1: No Action

Other than possibly monitoring groundwater concentrations, the no-action alternative requires no systems. This alternative is most appropriate for groundwater that has associated risk levels less than acceptable standards. No action may also be appropriate if all candidate remedial actions would result in either: 1) significant environmental damage, 2) great risk to human health, or 3) excessive cost, as compared to the level of risk reduction.

4.4.2 Alternative GW-2: Alternative Water Supply

This alternative eliminates the single currently existing exposure pathway for groundwater by providing city water to the owner of the Lewis Well. In addition, to prevent future exposure pathways, drilling of new water wells downgradient of the Monsanto Plant would be prohibited. The disadvantage of this remedial alternative is that is does not restore quality of the water or prevent groundwater transport of constituents off-site.

4.4.3 Alternative GW-3: Groundwater Extraction, Treatment, and Disposal

The elements in this alternative include:

- Extract groundwater with vertical wells
- Treat groundwater using precipitation/sedimentation
- Recharge treated groundwater to subsurface via an infiltration pond
- Remove water from sedimentation sludge using a belt filter press
- Return water from belt filter press sludge to precipitation operation
- Landfill filter solids.

This remedial alternative relies upon groundwater extraction from vertical wells to prevent migration of a plume off-site, and facilitate removal of the constituents of potential interest from the groundwater in an above-ground treatment system. Additional monitoring wells would be necessary to define the limits of the plume and monitor performance of the extraction system. The groundwater treatment system would rely upon precipitation and sedimentation to remove metal constituents of interest. Additional treatment, such as ion exchange, may be necessary if fluoride or ammonium require removal. Treated groundwater would be recharged to the subsurface using an infiltration pond. Liquid in the sedimentation sludge would be removed using a belt filter press and returned to the precipitation operation. The filter solids would be landfilled. Bench scale and pilot scale treatability studies would be necessary to design the treament system.

4.4.4 Alternative GW-4: Upgradient Groundwater Diversion, Groundwater Extraction, Treatment, and Disposal

The elements of this remedial alternative are:

- Extraction of clean upgradient groundwater using horizontal wells
- Injection of extracted groundwater downgradient of the plume using horizontal wells
- Capture groundwater plume with vertical wells
- Treat groundwater using precipitation/sedimentation
- Recharge treated groundwater to subsurface via an infiltration pond
- Remove water from sedimentation sludge using a belt filter press
- Return water from belt filter press to precipitation operation
- Landfill filter solids.

The key element of this alternative is minimization of the hydraulic gradient in the region of the plume by extracting clean groundwater upgradient of the plume and returning it to the aquifer downgradient of the plume. A flatter hydraulic gradient reduces the amount of groundwater extraction and treatment necessary to maintain capture of the plume. This alternative is best suited for the UBZ-2 plume because it takes advantage of the no-flow boundaries created by the faults on each side of the plume. Horizontal wells would be used for extraction and injection of the clean upgradient groundwater. Aquifer testing would be required to design the horizontal wells. In addition, pilot testing of horizontal well drilling and installation techniques would be necessary. The groundwater treatment system would be the same as described in Section 4.4.3.

4.5 Development of Alternatives for Air

The constituents of most interest for air include cadmium and fluoride. Exposure pathways of interest for air include: 1) inhalation or direct contact with fugitive dust, and 2) deposition onto soils. All of the remediation alternatives for soil are suitable for control of air emissions. Three additional alternatives for air are described below.

4.5.1 Alternative AIR-1: No Action

Other than monitoring air concentrations, the no-action alternative requires no systems. This alternative is for air emissions that have associated risk levels below acceptable standards.

4.5.2 Alternative AIR-2: Surface Controls and Access Restrictions

The elements included within this alternative are:

- Grading
- Vegetation
- Deed restrictions
- Fencing

Topsoil and vegetation would be placed over the area of impacted material to reduce fugitive dust emissions. Although minor amounts of grading might be necessary to reduce steep slopes, grading to control run-off and infiltration would not be necessary. The access restrictions would be necessary to minimize the potential for disturbance of the vegetation.

4.5.3 Alternative AIR-3: Surface Controls and Access Restrictions

The elements included within this alternative are:

- Grading
- Gravel Armor
- Deed Restrictions
- Fencing

This remedial alternative is similar to AIR-2 except gravel armor is used instead of vegetation. The purpose of grading would be to create a smooth upper surface on the source material with minimal slopes. A well-prepared surface would minimize erosion and allow complete coverage of the source material with a thin layer of gravel armor. The gravel armor would be designed to minimize wind and water erosion of the source material. The access restrictions would be intended to reduce the potential for disturbance of the gravel layer.

5. ACTION-SPECIFIC POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Remedial actions at the Monsanto Plant are required to comply with federal and state environmental laws and promulgated standards, requirements, criteria and limitations that are legally applicable or relevant and appropriate under the circumstances presented by the release or threatened release of hazardous substances, pollutants or contaminants. This is referred to as compliance with ARARs.

An ARAR is applicable if the specific terms (or jurisdictional prerequisites) of the law or regulations directly address a constituent, remedial action, or other circumstance at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if circumstances at a site are, based on professional judgement, sufficiently similar to situations regulated by the requirements on sites.

The EPA has developed a two-volume guidance document for evaluating ARARs, called CERCLA Compliance with Other Laws Manual: Interim Final (EPA 1988b). This guidance defines the three categories of ARARs as follows:

- Location-specific ARARs that set restrictions on activities relating to the characteristics of a site or its immediate environs
- Action-specific ARARs that set controls, limits or restrictions on performance or design activities related to remedial actions or management of constituents
- Constituent-specific ARARs that are health or risk-based numerical values or methodologies, which applied to site-specific conditions, result in the establishment of numerical values. These values set the acceptable amount or concentration of a constituent that may be found in, or discharged to, the ambient environment.

The EPA may waive ARARs under the five provisions that may be applied to private party remediations (CERCLA 121(d)(4)):

1) The action selected is only part of a total remedial action that will attain such level or standard of control when completed.

2) Compliance with such requirement at the facility will result in greater risk to human health and the environment than alternative options.

3) Compliance is technically impracticable from an engineering perspective.

4) The action selected will result in a standard of performance that is equivalent to an applicable requirement through the use of another method or approach.

5) A state requirement has not been equitably applied in a similar circumstances on other remedial actions within the state.

5.1 Potential Action-Specific Federal ARARs

Action-specific Federal ARARs are mandated by Federal regulations that set controls, limits or restrictions on performance or design activities related to remedial actions or management of constituents.

5.1.1 Underground Injection Control Program

The federal UIC program is described in 40 CFR 144 (Underground Injection Control Program) and 40 CFR 146 (Underground Injection Control Program: Criteria and Standards). These regulations apply to any underground injection well which is defined as a bored, drilled or driven shaft, or dug hole, whose depth is greater than the largest surface dimension. Injection fluid is defined as any material or substance which flows or moves whether in a semisolid, liquid, sludge, and gas form or state. These regulations could only be applicable or relevant and appropriate if a wastewater disposal facility matching the above definition is planned for the remedial system.

5.1.2 National Pollutant Discharge Elimination System

The federal NPDES program is described in 40 CFR 122 (EPA Administered Permit Programs) and 40 CFR 125 (Criteria and Standards). The NPDES program requires permits for the discharge of pollutants from any point source into the waters of the United States. Pollutants are defined as dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste that are discharged into water. These regulations could only be relevant and appropriate if the remedial system includes discharge of liquid effluent to Soda Creek or other surface water body. An NPDES permit is currently in place at the facility for discharge of non-contact process cooling water to Soda Creek.

The guidelines for indicating when pollutants need to be analyzed are set down in Guidelines Establishing Test Procedures for the Analysis of Pollutants (40 CFR 136). Pollutants are required to be measured for: a) application to the EPA, or state approved NPDES program under the Clean Water Act (CWA); b) NPDES required reports with discharging, and; c) for certifications issued by states under CWA regulations. These regulations could be applicable or relevant and appropriate if waste water discharges to surface water are required for actions at the Monsanto Plant.

5.1.3 Reporting of Release of Substances to United States Waters

Regulations for reporting releases of constituents (hazardous and statutory) are established in 40 CFR 302 (Designation, Reportable Quantities, and Notification). Notification requirements are set down for the identified reportable quantities of constituents if released to the environment. These regulations could be applicable or relevant and applicable if there is a release of enough of a constituent to be considered a reportable quantity to the environment.

5.1.4 Occupational Safety and Health Act

The OSHA program is described in 29 CFR 1910 and 29 CFR 1926 (Occupational Safety and Health Standards). This program contains occupational safety and health standards which have been found to be national consensus standards or established Federal standards. Standards are provided for practices, means, methods, operations, or processes that are considered reasonably necessary or appropriate to provide safe and healthful employment and places of employment. This regulation could be applicable or relevant and appropriate to any labor conducted at the Monsanto Plant in the remediation system.

5.1.5 Safe Drinking Water Act

The federal Safe Drinking Water Act is described in 42 USC 300. This regulation promulgates drinking water regulations designed to protect human health from potential adverse effects of drinking water. These regulations establish clean up goals and standards for remedial actions, including maximum contaminant levels (MCL), maximum contaminant level goals (MCLG), and secondary maximum contaminant levels (SMCL). These goals and standards must be considered in remedial activities at the Monsanto Plant that will affect groundwater or surface water that may be used for human consumption now or in the future.

5.1.6 National Emission Standards for Hazardous Air Pollutants

The national emission standards for hazardous air pollutants are descibed in National Emission Standards for Hazardous Air Pollutants (40 CFR 61). These regulations list substances that have been designated as hazardous air pollutants and consider the possible seriou health effects with ambient air exposure. This regulation would be applicable for any remedial actions that result in the release of hazardous air pollutants.

5.1.7 Resourse Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) lists solid wastes that are regulated as hazardous wastes in 40 CFR 261.3. Solid wastes (including slag from elemental phosphorus production) generated from the extraction, benefication, and processing of ores (restricted to selected activities) are excluded from this listing (40 CFR 261.4). Monsanto has evaluated all of the processing waste streams and activities throughout the Plant for hazardous waste characterization. Appropriate measures have been made to comply with RCRA requirements regarding non-exempt waste streams that were characterized as hazardous. A RCRA permit for the Plant was deemed not necessary, based on current operations and regulations.

The mining exclusion would not apply to solid wastes generated as a result of remedial activities. Any solid wastes resulting from remedial activities would require assessment with regards to the hazardous waste criteria discussed in 40 CFR 261 regarding waste characteristics, toxicity, and listed wastes.

5.2 Potential Action-Specific State ARARs

Action-specific state ARARs are mandated by state regulations that set controls, limits or restrictions on performance or design activities related to remedial actions or management of constituents.

5.2.1 Underground Injection Control Program

The state UIC program is described in State UIC Program Requirements (40 CFR 145) and State Underground Injection Control Programs (40 CFR 147). The definition of an underground injection well is provided for in Rules and Regulations: Construction and Use of Injection Wells, IDHW (1984). An injection well is any excavation or artificial opening into the ground which meets the following three criteria: a) it is a bored, drilled or dug hole, or is a driven mine shaft or a driven well point, and; b) it is deeper than its largest straight-line surface dimension; and, c) it is used for or intended to be used for injection. Injection is defined as the subsurface emplacement of fluids, fluids being any material or substance which flows or moves whether in a semisolid, liquid, sludge, gaseous or any other form or state. These regulations could be applicable or relevant and appropriate if a wastewater disposal facility meeting the above definition is included as part of the remedial system.

5.2.2 Idaho Water Quality Standards and Wastewater Treatment Requirements

The state water quality standards and wastewater treatment requirements are described in Idaho Administrative Procedures Act (16.01.2000 et. seq.). These regulations set general water quality standards for waters of the state, including groundwater. They also establish a policy for protection of beneficial uses of groundwater, and designate groundwaters of the state for use as potable water supply unless existing water quality precludes economic feasibility. These regulations could be applicable or relevant and appropriate if any remediation actions impact groundwaters or involve wastewater treatment.

5.2.3 Idaho Solid Waste Management Regulations

The state solid waste management regulations are discussed in IDHW, Title 1, Chapter 6, Sections 01.6001 et. seq.. These regulations apply to handling and disposal of mining constituents excluded from RCRA Subtitle C, and Idaho Hazardous Waste Management Regulations. They require that solid constituents be managed in a manner which ensures that the constituents do not physically impair the environment to the detriment of man and beneficial plant life, fish and wildlife. The regulations also include provisions for dust control at any sanitary landfills. These regulations could be applicable or relevant and appropriate if there are mining constituents or sanitary landfills at the Monsanto facility containing solid constituents that are not regulated as hazardous waste.

5.3 Potential Location-Specific ARARs

Location-specific ARARs set restrictions on activities relating to the characteristics of a site or its immediate environs. Typical location-specific ARARs address landmarks, historical and archeological sites, wetlands, floodplains, important farmlands, coastal zones, wild and scenic rivers, fish and wildlife, endangered species, and air quality concerns. No location-specific ARARs have been identified for the Monsanto Plant.

6. SUMMARY

The Phase I FS Report develops preliminary remedial alternatives that could potentially satisfy the remedial action objectives identified for the Monsanto Plant. Remedial alternatives were developed based on the tasks outlined in the work plan, including:

- Preliminary development of remedial action objectives
- Preliminary development of general response actions
- Preliminary identification of potential remedial technologies
- Preliminary evaluation of process options

The results of these four tasks are summarized in Sections 2 and 3 of this report. These tasks were preliminary because the remedial action objectives will not be finalized until after the risk assessment is completed by EPA.

Preliminary remedial alternatives are developed in Section 4. Remedial alternatives were developed for all media identified in the RI that had constituent concentrations that could potentially exceed acceptable levels of risk. A total of 22 remedial alternatives were developed, including five for source materials, six for soils, four for sediments, four for groundwater, and three for air.

The work plan called for an additional three tasks to be included within the Phase I FS:

- Preliminary identification of action-specific and location-specific ARARs
- Preliminary screening evaluation
- Reevaluation of data needs

Action-specific and location-specific ARARs are identified in Section 5. The screening evaluation could not be completed until after the risk assessment is complete and the remedial objectives are refined. Finally, no additional data needs, beyond those identified in the RI, appear to warrant additional investigations at this time. It is anticipated that following completion of the risk assessment, the range of effective remedial alternatives will become more apparent and additional data needs will be identified.

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TABLES

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TABLE 1-1

PRELIMINARY RISK SCREENING OF ELEVATED NON-RADIOACTIVE CONSTITUENTS IN A GROUP (0 TO 1 IN) AND B GROUP (0 to 6 IN) SOILS

Elevated Constituent	Maximum Concentration (mg/kg)		Non-Carcinogenic Effects		Carcinogenic Effects	
			Soil Ingestion	Soil Inhalation	Soil Ingestion	Soil Inhalation
	A Group Soils	B Group Soils	0.5 RfC (mg/kg)	0.5 RfC (mg/kg)	RSC (mg/kg)	RSC (mg/kg)
arsenic	34	10	40.5[a]	-	0.04	13.62[b]
beryllium	4	3.5	675	-	0.01	81.07
cadmium	168	N/A	67.5[b]	-	-	108.10[b]
manganese	N/A	3,440	13,500	2,900[c]	-	-

NOTE: Shaded areas indicate screening criterion exceeded
RfC Reference concentration, based on respective constituent-specific reference doses.
RSC Risk-specific concentration at lifetime incremental cancer risk (LICR) = 1E-06, based on respective constituent-specific oral or inhalation slope factors.
\- No data
a Surrogate calculated from proposed arsenic unit risk of 5E-5 μg/L from HEAST (EPA 1991)
b Criteria exceeded in A Group soils only
c Criteria exceeded in B Group soils only
N/A Not applicable, constituent concentrations did not excceed control values in this group

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TABLE 1-2

PRELIMINARY RISK SCREENING OF ELEVATED RADIOLOGICAL CONSTITUENTS IN A GROUP (0 TO 1 IN) AND B GROUP (0 TO 6 IN) SOILS

Radiological Constituent	Units	Maximum Concentration		Inhalation Fugitive Dust RSC	Ingestion Soil RSC	External Exposure RSC
		A GROUP SOILS	B GROUP SOILS			
lead-210	(pCi/g)	65	32	95	1.2	220
polonium-210	(pCi/g)	77	34	150	5.3	1200
radium-226	(pCi/g)	17	6.2	130	6.6[a]	0.0058
thorium-230	(pCi/g)	18	18	13	61	640
uranium	(pCi/g)	16	6.4	7.3[a]	28	0.97

NOTE: Shaded areas indicate screening criterion exceeded

RSC Risk-specific concentration at lifetime incremental cancer risk (LICR) = 1E-06, based on respective constituent-specific inhalation, ingestion, or external slope factors

[a] Criteria exceeded in A Group soils only

TABLE 1-3

PRELIMINARY RISK SCREENING OF ELEVATED CONSTITUENTS IN FRESH GROUNDWATER

Elevated Constituent	Maximum Concentration (mg/L)	Non-Carcinogenic Effects	Carcinogenic Effects	1° MCL (mg/L)	2° MCL (mg/L)	MCLG (mg/L)	WQC-HH (mg/L)	WQC-HW (mg/L)	WQC-FWC (mg/L)
		0.5 RfC(mg/L)	RSC (mg/L)						
arsenic	0.02	0.006	0.00005[d]	0.05	-	0.05	0.00002	-	0.19
cadmium	8	0.009	-	0.005	-	0.005	0.01[g]	-	0.0042[h]
manganese	1.33	1.9	-	-	0.05[j]	-	-	0.05	-
nickel	0.14	0.4	-	-	-	-	0.1	-	1.2
selenium	0.289	0.09	-	0.05	-	0.05	0.01	-	0.05
zinc	14.1	4	-	-	5[j]	-	-	5	0.44
total dissolved solids	2668	-	-	-	500[j]	-	-	-	-
ammonium as N	3.9	7.4E+05[a]	-	-	-	-	-	-	2.0[i]
chloride	679	-	-	-	250[j]	-	-	250	-
fluoride	19.93	1.1	-	-	2[j]	4	-	-	-
nitrate/nitrite as N	35.2	29.6[b]	-	10	-	10	-	-	-
sulfate	700	-	-	-	250[j]	-	-	250[j]	-
phosphorus	3.72	0.0004[c]	-	-	-	-	-	-	0.0001[c]
radium-226	3.4[e]	-	0.4[f]	-	-	-	-	-	-

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TABLE 1-3 (Cont.)

PRELIMINARY RISK SCREENING OF ELEVATED CONSTITUENTS IN FRESH GROUNDWATER

NOTE:	Shaded areas indicate screening criterion exceeded
RfC	Reference concentration based on the constituent-specific oral reference dose
RSC	Risk-specific concentration at lifetime incremental cancer risk (LICR) = 1E-06, based on the constituent-specific oral slope factor
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goals
WQC-HH	Water quality criterion for the protection of human health from potential toxic effects associated with the ingestion of aquatic organisms
WQC-HW	Water quality criterion for the protection of human welfare
WQC-FWC	Water quality criterion for the protection of freshwater aquatic life — chronic
-	No data
a	Based on the RfD for free ammonia (34 mg/kg·d; EPA 1991). Ratio of ammonium as N to ammonia (1,200) is based on a groundwater temperature of 12°C and pH of 6.5 at the location of maximum ammonium concentration.
b	Value for nitrate only
c	Criterion applicable to phosphate, not total phosphorus as analyzed; therefore constituent is not of potential interest
d	Surrogate calculated from proposed arsenic unit risk of 5E-05 µg/L from HEAST (EPA 1991)
e	Units in pCi/L
f	Units in (1/pCi)
g	Value represents the former MCL
h	Hardness-dependent criterion- assumes an average hardness of 530.9 mg/L for Soda Creek downstream of effluent discharge
i	Temperature- and pH-dependent criteria- assumes temperature=7°C, pH=7.2 for Soda Creek downstream of effluent discharge
j	Welfare criteria exceedance not used to be determine constituents of potential interest

TABLE 2-1

SUMMARY OF CONSTITUENTS OF POTENTIAL INTEREST AT THE MONSANTO PLANT

Constituent	Environmental Medium					
	Surface Water	Downstream Sediments		Soils		Groundwater
		100 ft	300 ft	Surface (0-1 in)	Subsurface (0-6 in)	
Arsenic	-	-	-	X	X	X
Beryllium	-	-	-	X	X	-
Cadmium	-	X	-	X	-	X
Copper	-	X	-	-	-	-
Manganese	-	-	-	-	X	-
Nickel	-	X	-	-	-	X
Selenium	-	X	X	-	-	X
Silver	-	X	X	-	-	-
Vanadium	-	X	X	-	-	-
Zinc	-	-	-	-	-	X
Ammonium	-	-	-	-	-	X
Fluoride	-	-	-	-	-	X
Nitrite/Nitrate	-	-	-	-	-	X
Lead-210	-	-	-	X	X	-
Polonium-210	-	X	-	X	X	-
Radium-226	-	-	-	X	X	X
Thorium-230	-	-	-	X	X	-
Uranium	-	-	-	X	X	-

X Constituent of potential interest in this medium

TABLE 3-1

ESTIMATED AREAS, VOLUMES OR WEIGHTS OF MEDIA AFFECTED BY CONSTITUENTS OF POTENTIAL INTEREST

Media	General Location	Estimated Areal Extent (yd^2)	Estimated Volume, Weight, or Flow Rate
Calcium Silicate Slag Pile	SW central to SE corner	4.7×10^5	2.3×10^7 tons total, 7.0×10^5 tons/yr produced
Baghouse Dusts	NW corner	Pile 1- 6.7×10^3 Pile 2- 6.7×10^3 Total - 1.3×10^4	Pile 1- 6.7×10^4 CY Pile 2- 6.7×10^4 CY Total - 1.3×10^5 CY
Underflow Solids	NE corner and N central	Pile 1- 6.6×10^4 Pile 2- 3.3×10^4 Pile 3- 5.3×10^4 Total - 1.5×10^5	Pile 1- 1.1×10^6 CY Pile 2- 3.3×10^5 CY Pile 3- 5.3×10^5 CY Total - 2.0×10^6 CY
Coke and Quartzite Slurry Pond	SW corner	1.3×10^4	4.2×10^4 CY
Non-Contact Cooling Water Effluent	SW corner		600 to 1,200 gpm
Sediments	Soda Creek (off-site)	440	150 CY
Soils	entire site	2.6×10^6	4.3×10^5 CY
	entire site and 1,000 foot perimeter	5.4×10^6	9.0×10^5 CY
Groundwater	UBZ-2 cadmium	4.9×10^5	2.0×10^8 gal
	UBZ-4 cadmium	2.2×10^5	8.8×10^7 gal
	UBZ-1 chloride	2.5×10^5	1.0×10^8 gal
	UBZ-2 chloride	8.5×10^5	3.4×10^8 gal
	UBZ-4 chloride	4.4×10^5	1.8×10^8 gal
	LBZ-2 cadmium	3.0×10^4	1.2×10^7 gal
	LBZ-2 chloride	1.9×10^5	7.5×10^7 gal

GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR SOLIDS (SOURCE MATERIALS, SOILS, AND SEDIMENTS).

General Response Actions	Remedial Technology Types	Process Options	Retain or Reject
No action	No action	No action	Retain
Institutional actions	Access restrictions	Fencing Deed restrictions	Retain
Containment	Covers	Clay Synthetic membrane Asphalt/concrete Slag	Retain
	Vertical barriers	Slurry wall Injected grout wall Sheet piling	Reject
	Surface controls	Grading Vegetation Water application Chemical stabilization Gravel armor Diversion/collection	Retain
Stabilization	Thermal	In-situ vitrification	Reject
	Grouting	Cement/bentonite or Possolamic agents	Retain
Removal/Treatment /Disposal	Excavation	Excavation	Retain
	Encapsulation	Steel drums or tanks Concrete vaults	Reject
	Solids disposal	Landfill Clean fill Recycling	Retain
	Washing	Water washing Chemical extraction	Retain
	Dewatering	Filter press Belt filter press Vacuum filtration Dewatering beds	Retain
In-situ treatment	In-situ flushing	Water flushing Chemical extraction	Retain
	In-situ fixation	In-situ fixation	Reject

GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR GROUNDWATER.

General Response Actions	Remedial Technology Types	Process Options	Retain or Reje
No action	No action	No action	Retain
Institutional actions	Access restrictions	Deed restrictions	Retain
	Alternative water supply	Alternative water supply	Retain
Containment	Vertical barriers	Slurry walls Sheet piling Injected grout curtain In-situ filtration	Retain
Extraction/treatment/disposal	Groundwater extraction	Vertical wells Horizontal wells Interceptor trenches	Retain
	Physical treatment	Coagulation/Flocculation Carbon adsorption Sedimentation Filtration Evaporation Freeze crystallization Reverse osmosis	Retain
	Chemical treatment	Precipitation Ion-exchange Oxidation/reduction Electrolysis Electrodialysis	Retain
	Biological treatment	Nitrification/Denitrification Bio-fix beads	Retain
	Surface disposal	Sanitary-sewer system Surface-water Re-use	Retain
	Subsurface disposal	Shallow infiltration trench Infiltration pond	Retain
In-situ treatment	In-situ fixation	In-situ fixation	Reject
	In-situ chemical extraction	Chemical extraction	Reject

GENERAL RESPONSE ACTIONS, REMEDIAL TECHNOLOGY TYPES, AND PROCESS OPTIONS FOR AIR

General Response Actions	Remedial Technology Types	Process Options	Retain or Reject
No action	No action	No action	Retain
Institutional actions	Access restrictions	Fencing Deed restrictions	Retain
Containment	Capping	Clay Synthetic Membrane Asphalt/Concrete Slag	Retain
	Surface Controls	Grading Vegetation Water Application Chemical Stabilization Gravel Armor Diversion/collection	Retain

TABLE 3-5

COMPARISON OF PROCESS OPTIONS FOR SOLIDS (SOURCE MATERIALS, SOILS, AND SEDIMENTS)

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
No action	No action	Effective for materials that pose little risk.	Requires that risk levels are below acceptable standards.	Low	Good
Access restrictions	Fencing	Reduces risk associated with direct exposure.	Already in place.	\$10-15/foot (Mahoney 1988)	Good
	Deed restrictions	Reduces risk associated with direct exposure.	May reduce value of property. Poatentially difficult to enforce.	Indirect costs only	Average
Covers	Clay	Reduces infiltration. May require surface stabilization to reduce erosion. Effectiveness reduced if cracking occurs due to desiccation.	Difficult to install on steep slopes, suitable source materials needed.	\$10-20/yard[2] (EPA 1985a)	Good
	Synthetic membrane	Reduces infiltration and erosion. Susceptible to degradation from weather.	Not suitable for vehicle traffic.	\$2-20/yard[2] (EPA 1985a)	Average
	Asphalt or concrete	Reduces both infiltration and erosion. Well suited for heavily trafficed areas, may be susceptible to cracking.	Difficult to install on steep slopes.	\$5-20/yard[2] (EPA 1985a, Mahoney 1988, Rishel et al. 1984)	Good
	Slag	Effectiveness not documented.	Difficult to control thickness and quality of slag. Safety concerns with molten slag.	Testing costs only	Average
Surface controls	Grading	May reduce infiltration rate and erosion.	Good.	\$1-5/yard[2] (EPA 1985a and 1991a, Rishel et al. 1984)	Good
	Vegetation	Reduces infiltration and erosion.	Good.	\$0.5-3/yard[2] (EPA 1985a, Rishel et al. 1984)	Good
	Water application	Effective for temporary dust suppression.	Good in situations where infiltration would not increase chemical migration.	Low	Average
	Chemical stabilization	Effective for dust suppression, does not increase infiltration rates.	Environmental impact of product must be minimal.	Uncertain	Average
	Gravel armor	Effective for suppression of dust generation and erosion.	Good.	\$2-4/yard[2] (Mahoney 1988)	Good
	Diversion/collection	Effective for reducing off-site chemical transport in runoff.	Good.	Variable	Good

TABLE 3-5 (Cont.)

COMPARISON OF PROCESS OPTIONS FOR SOLIDS (SOURCE MATERIALS, SOILS, AND SEDIMENTS)

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
Grouting	Cement/bentonite or Possolamic agents	Difficult to predict and verify effectiveness.	Good.	$60-325/yard^3 (HMC 1990, EPA 1991a)	Average
Excavation	Excavation	Allows complete elimination of risk from site.	Only applicable for unconsolidated overburden, not basalt.	$1-7/yard^3 (EPA, 1985a, Mahoney 1988)	Average
Solids disposal	Landfill	Allows complete elimination of risk from site.	Not feasible for large waste volumes.	$100-300/yard^3 (EPA 1985a, Czupyrua et al, 1989)	Average
	Clean fill	Level of risk reduction depends upon level of treatment.	Requires treatment to acceptable levels and a receiving location.	Low	Good
	Recycling	Allows complete elimination of risk.	Material must provide a beneficial use.	Low	Good
Washing	Water washing	Effective for coarse-grained materials, can reduce concentrations by 1 to 2 orders of magnitude.	Requires additional treatment or disposal of slurry.	Variable	Good
	Chemical extraction	May achieve greater chemical concentration reduction than water processing.	Treatment or disposal of resulting slurry will be necessary.	$135-2,700/yard^3 (Freeman 1989)	Good
Dewatering	Filter press	Effective for dewatering sludges.	Good.	Moderate	Good
	Belt filter press	Effective for dewatering sludges.	Good.	Moderate	Good
	Vacuum filtration	Effective for dewatering sludges.	Good.	Moderate	Average
	Dewatering beds	Effective for dewatering sludges, except in cold or wet weather.	May require permitting.	Low	Poor
In-situ flushing	Water flushing	Effective for remediation of vadose zone materials.	Requires regulatory approval.	Uncertain	Poor
	Chemical extraction	Effective for sites with a few, well-characterized constituents.	Requires regulatory approval.	Uncertain	Poor

(1) Cost estimates more than 5 years old have been corrected for inflation.

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TABLE 3-6

COMPARISON OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
No action	No action	Effective for groundwater that poses little risk.	Requires that risk levels are below acceptable standards.	Low	Good
Access restrictions	Deed restrictions	Effective for on-site groundwater use, not effective off-site.	May reduce property values.	Indirect costs only.	Average
Alternative water supply	Alternative water supply	Effective for reducing groundwater use, does not reduce concentrations.	Requires consent from users.	Low	Average
Vertical barriers	Slurry walls	Effective for controlling groundwater flow patterns, minimizing volumes for extraction.	Unfeasible due to basalt underlying site.	High	Poor
	Sheet piling	Generally less effective than slurry walls.	Unfeasible due to basalt underlying site.	High	Poor
	Injected grout curtain	May be effective for controlling groundwater flow patterns, minimizing volumes for extraction.	Potential installation problems.	High	Average
	In-situ filtration	Relatively untested in the field.	Unfeasible due to basalt underlying site.	Uncertain	Poor
Groundwater extraction	Vertical wells	Effective for groundwater remediation and control.	Good.	$10-40/ft	Good
	Horizontal wells	Effective for groundwater remediation and control.	Technology still under development.	Uncertain	Average
	Interceptor trenches	Effective for groundwater remediation and control.	Unfeasible due to basalt underlying site.	High	Poor
Physical treatment	Sedimentation	Effective for removal of suspended solids.	Good.	Low	Good
	Coagulation/Flocculation	Effective for enhancing sedimentation.	Good.	$15-25/1,000 gal (Palmer et al. 1988)	Good

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TABLE 3-6 (Cont.)

COMPARISON OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
Physical treatment	Carbon adsorption	Not effective for primary constituents of interest.	Good.	$5-200/1,000 gal (Palmer et al. 1988)	Poor
	Filtration	Effective only for removal of suspended solids.	Good.	Variable	Good
	Evaporation	Effective for volume reduction.	Solar requires large evaporation ponds and warm dry weather.	Variable	Average
	Freeze crystallization	Effective for constituents that have low affinity for inclusion into frozen water.	Not well tested.	$25-150/1,000 gal (Freeman 1989)	Poor
	Reverse osmosis	Effective for treatment of ionic constituents.	Potential problems with membrane fouling.	$1-5/1,000 gal (McArdle et al. 1988, Hauck et al. 1985)	Average
Chemical treatment	Precipitation	Effective for treatment of cadmium and other metals.	Good.	$1-32/1,000 gal (Palmer et al. 1988)	Good
	Ion-exchange	Effective for treatment of metals.	Good.	$2-10/1,000 gal (McArdle et al. 1988, Hauck et al. 1985)	Good
	Oxidation/reduction	Not effective for constituents of interest.	Good.	$3-400/1,000 gal (McArdle et al. 1988)	Poor
	Electrolysis	Effective for treatment of metals.	Good.	Variable	Average
	Electrodialysis	Effective for treatment of cadmium and other metals.	Potential problems with membrane fouling.	$2-10/1,000 gal (Porter 1990)	Average
Biological treatment	Nitrification/Denitrification	Effective for removal of nitrate and ammonium ion.	Difficult to operate	Variable	Average
	Bio-fix beads	Most effective for removal of low concentrations of metals at low flow rates.	Not well tested.	Uncertain	Poor

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TABLE 3-6 (Cont.)

COMPARISON OF PROCESS OPTIONS FOR GROUNDWATER

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
Surface disposal	Sanitary-sewer system	Effective for disposal of treated effluents.	Limited capacity, requires permitting.	Uncertain	Average
Surface disposal (Cont.)	Surface water	Effective for disposal of treated effluent.	Requires permit modifications.	Permitting, monitoring costs.	Good
	Re-use	May be effective for Plant production use, but ultimate discharge means still required.	Must be suitable for use at the Plant.	Low	Good
Subsurface disposal	Shallow infiltration trench	Effective for disposal of treated effluents.	Requires permitting. Potential for clogging.	$20-50/ft^2	Average
	Infiltration pond	Effective for disposal of treated effluents.	Requires permitting and large surface area.	Uncertain	Good

(1) Cost estimates more than 5 years old have been corrected for inflation.

June 5, 1992

TABLE 3-7

COMPARISON OF PROCESS OPTIONS FOR AIR.

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
No action	No action	Effective for air releases that pose little risk.	Requires that risk levels are below acceptable standards.	Low	Good
Access restrictions	Fencing	Effective for reduction of risk associated with on-site exposure.	Already in place.	Low	Average
	Deed Restrictions	Effective for reduction of on-site exposure.	May reduce value of property, potentialy difficult enforce.	Indirect cost only	Average
Covers	Clay	Reduces airborne transport of materials, but may require surface stabilization to reduce erosion.	Difficult to install on steep slopes, suitable source materials needed.	\$10-20/yard[2] (EPA 1985a)	Average
	Synthetic membrane	Reduces airborne transport of materials. Susceptible to degradation from weather.	Not suitable for vehicle traffic.	\$2-20/yard[2] (EPA 1985a)	Average
	Asphalt or concrete	Reduces airborne transport of materials. Well suited for heavily trafficed areas, may be susceptible to cracking.	Difficult to install on steep slopes.	\$5-20/yard[2] (EPA 1985a, Mahoney 1988, Rishel et al, 1984)	Good
	Slag	Reduces airborne transport of materials.	Difficult to maintain thickness and quality of slag. Safety concerns with molten slag.	Low	Poor

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TABLE 3-7 (Cont.)

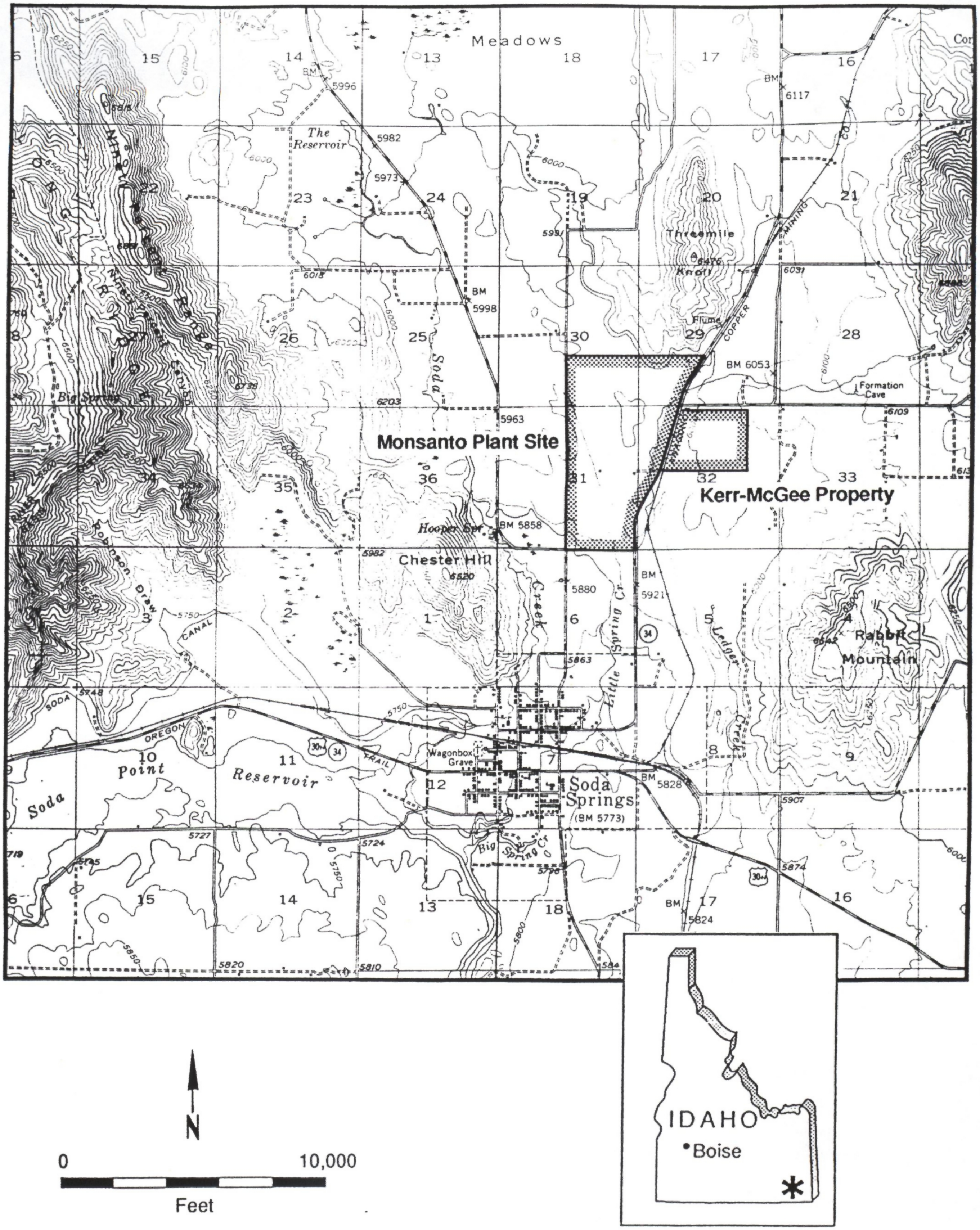
COMPARISON OF PROCESS OPTIONS FOR AIR.

Remedial Technology Types	Process Options	Effectiveness	Implementability	Cost[1]	Overall Assessment
Surface controls (Cont.)	Grading	Effective for surface preparation.	Good.	$1-5/yard^2 (EPA 1985a and 1991a, Rischel et al. 1984)	Good
	Vegetation	Reduces infiltration and erosion.	Good.	$0.5-3/yard^2 (EPA 1985a, Rischel et al. 1984)	Good
	Water application	Effective for temporary dust suppression.	Good in situations where infiltration would not increase chemical migration.	Low	Average
	Chemical stabilization	Effective for dust suppression, does not increase infiltration rates.	Environmental impact of product must be minimal.	Uncertain	Average
	Gravel armor	Effective for suppression of dust generation and erosion.	Good.	$2-4/yard^2 (Mahoney 1988)	Good
	Diversion/collection	Not effective for reducing fugitive dust.	Good.	Variable	Poor

(1) Cost estimates more than 5 years old have been corrected for inflation.

Figures

FIGURES



SOURCE: Topographic Map of the USGS
Soda Springs Quadrangle (1:62,500) 1948.

FIGURE **1-1**
LOCATION MAP
MONSANTO/PHASE 1 FS REPORT/ID

PROJECT NO. 913-1101.309 DRAWING NO. 28713 DATE 5/15/92 DRAWN BY TK

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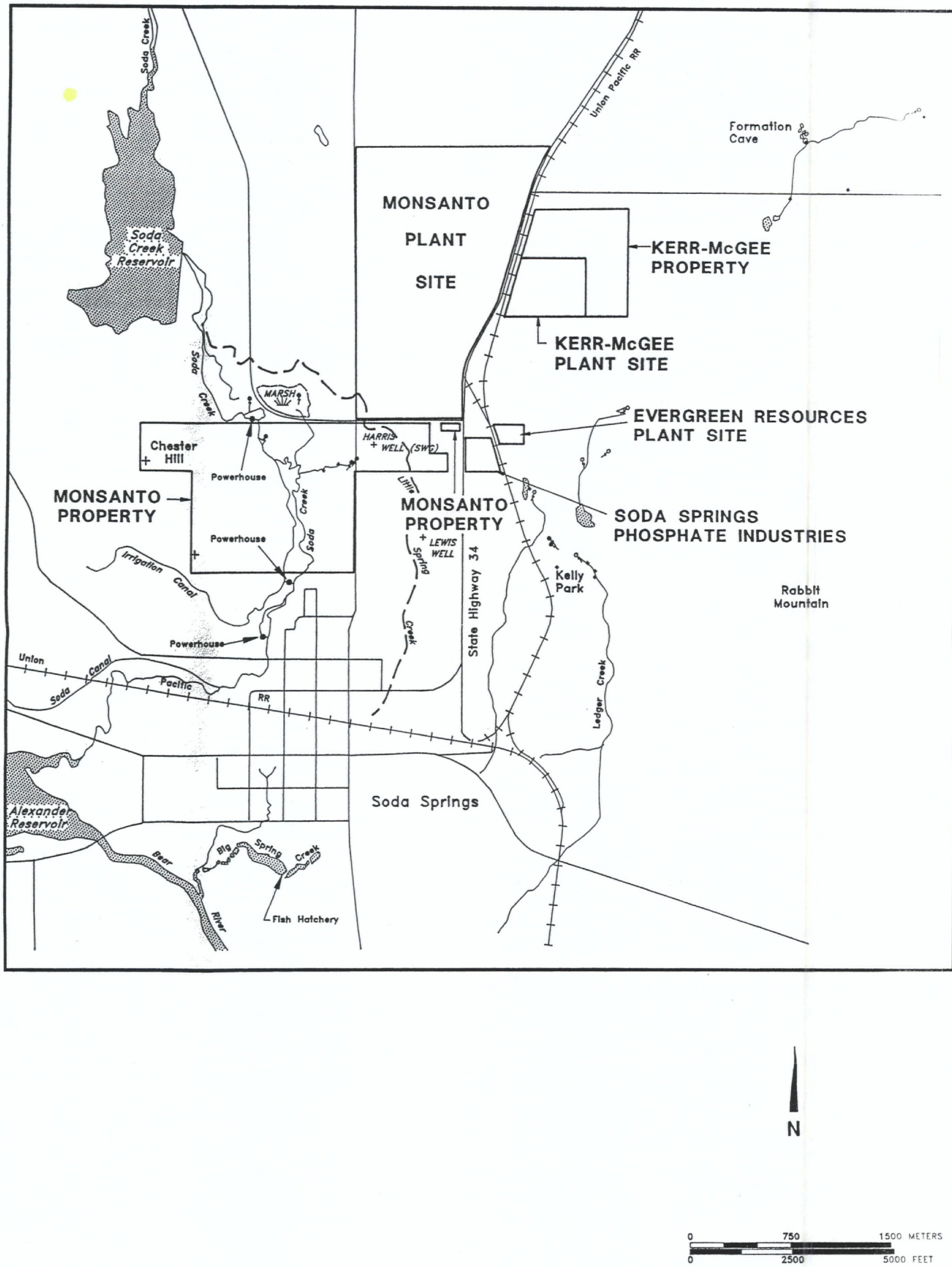

NOTE:
Evergreen Resources and Soda Springs Phosphate Industries plant boundaries are approximate.

FIGURE 1-2
MONSANTO PLANT VICINITY
MONSANTO/PHASE I FS REPORT/ID

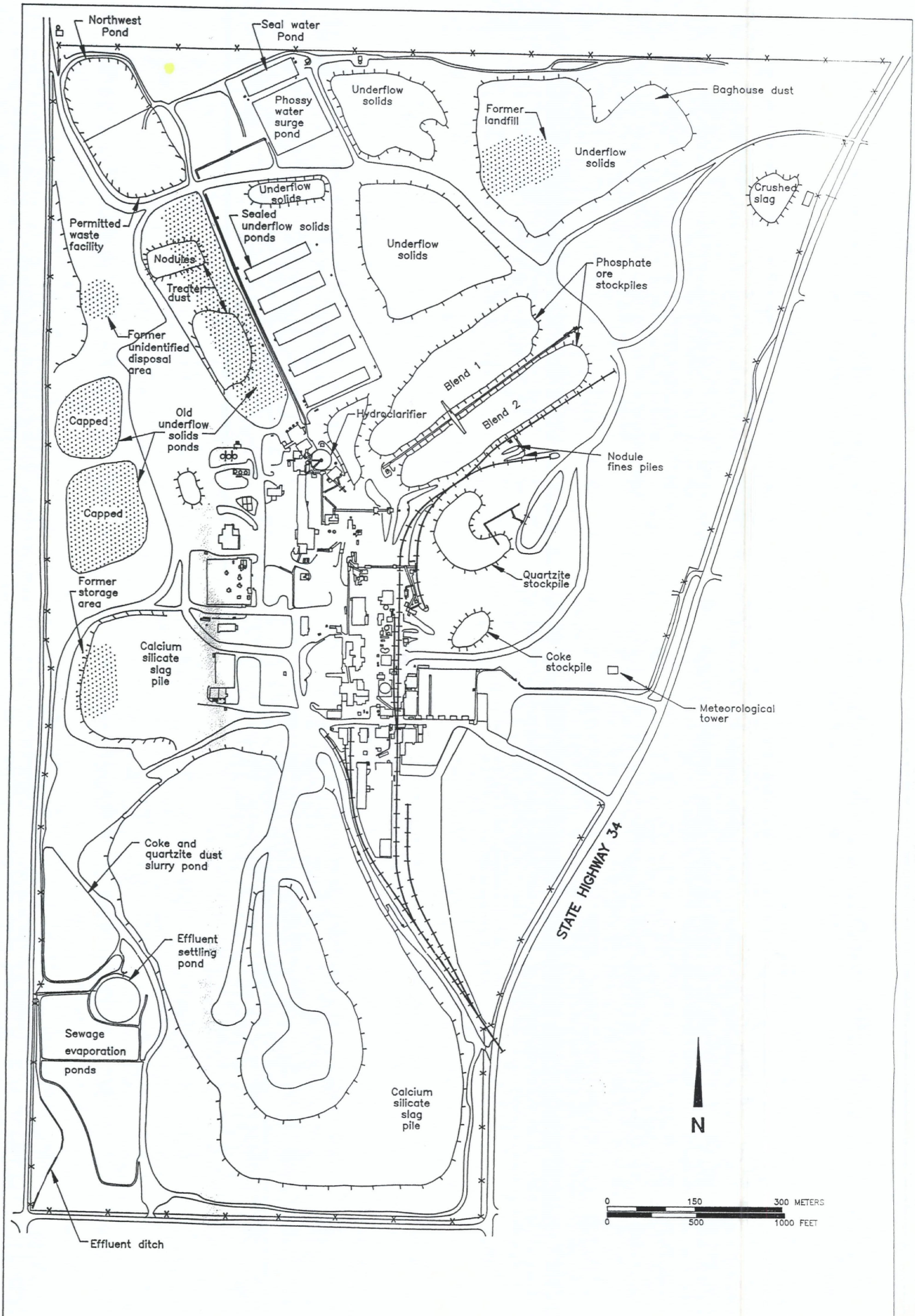

FIGURE 1-3
MONSANTO FACILITY MAP
MONSANTO/PHASE I FS REPORT/ID

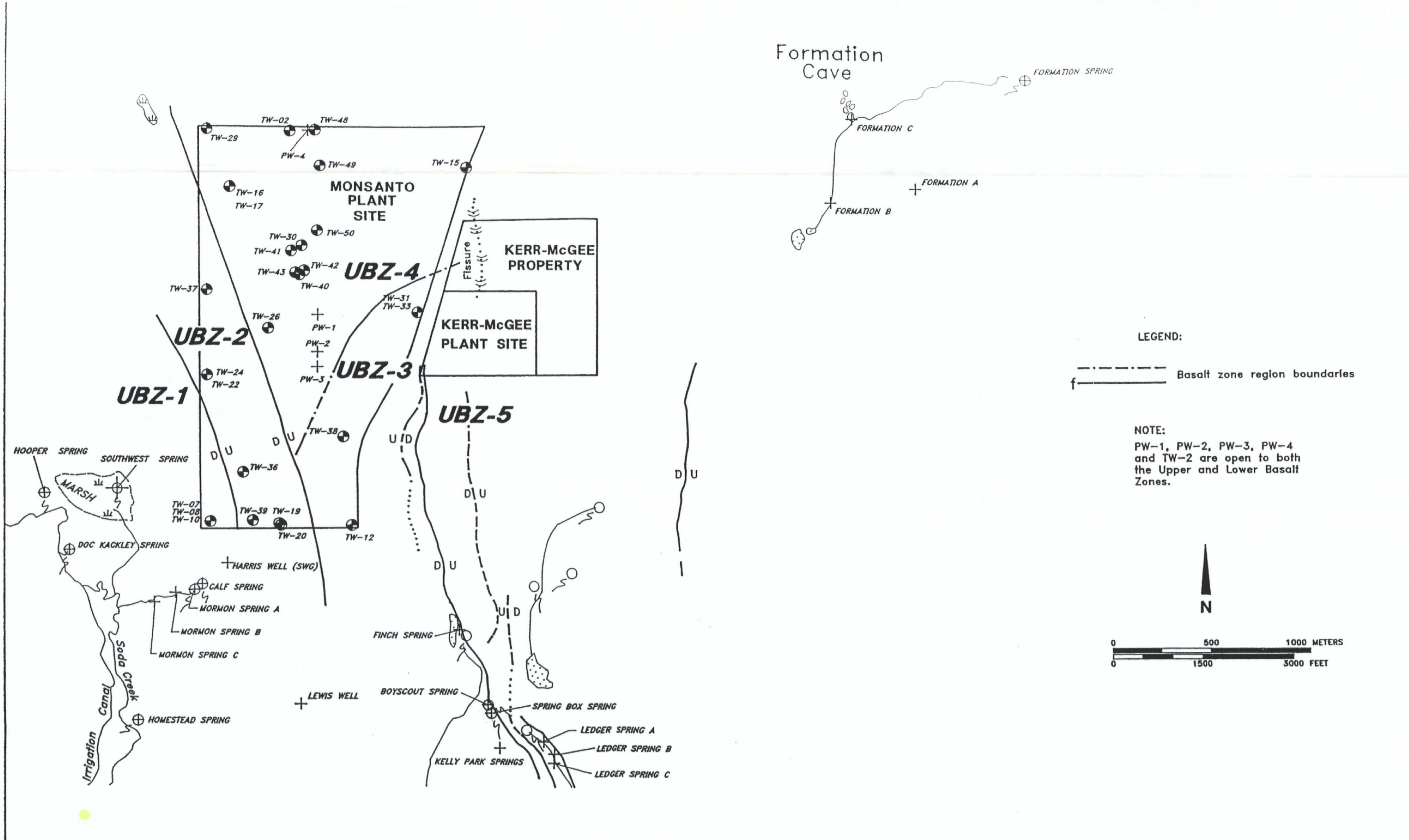

FIGURE **1-4**

UPPER BASALT ZONE REGIONS

MONSANTO/PHASE I FS REPORT/ID

PROJECT NO 913-1101/309 DWG NO 31755 DATE 6-4-92 DRAWN PM

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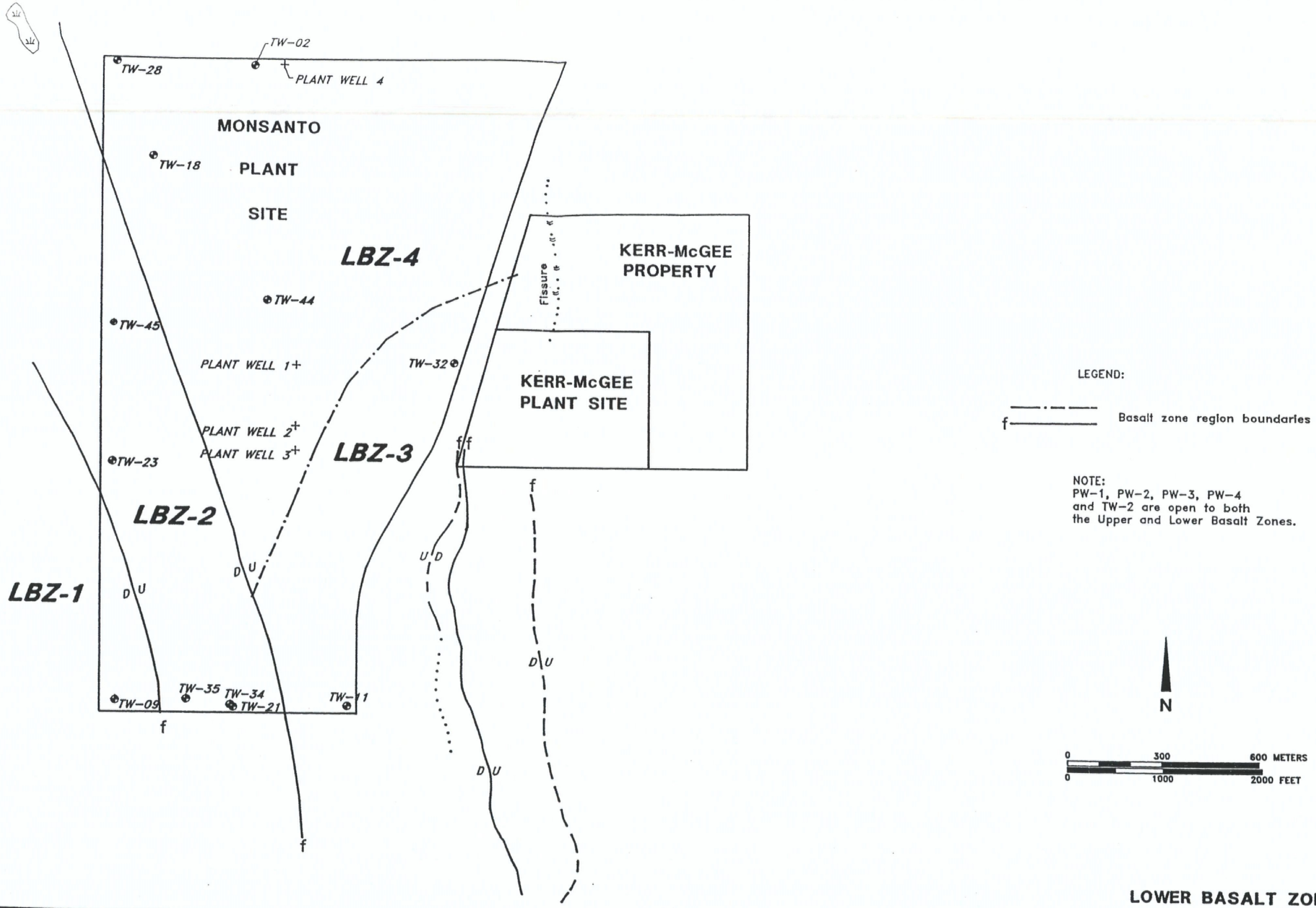

FIGURE **1-5**

LOWER BASALT ZONE REGIONS

MONSANTO/PHASE I FS REPORT/ID

PROJECT NO913-1101.309 DWG NO 31754 DATE 6-4-92 DRAWN PM

Golder Associates

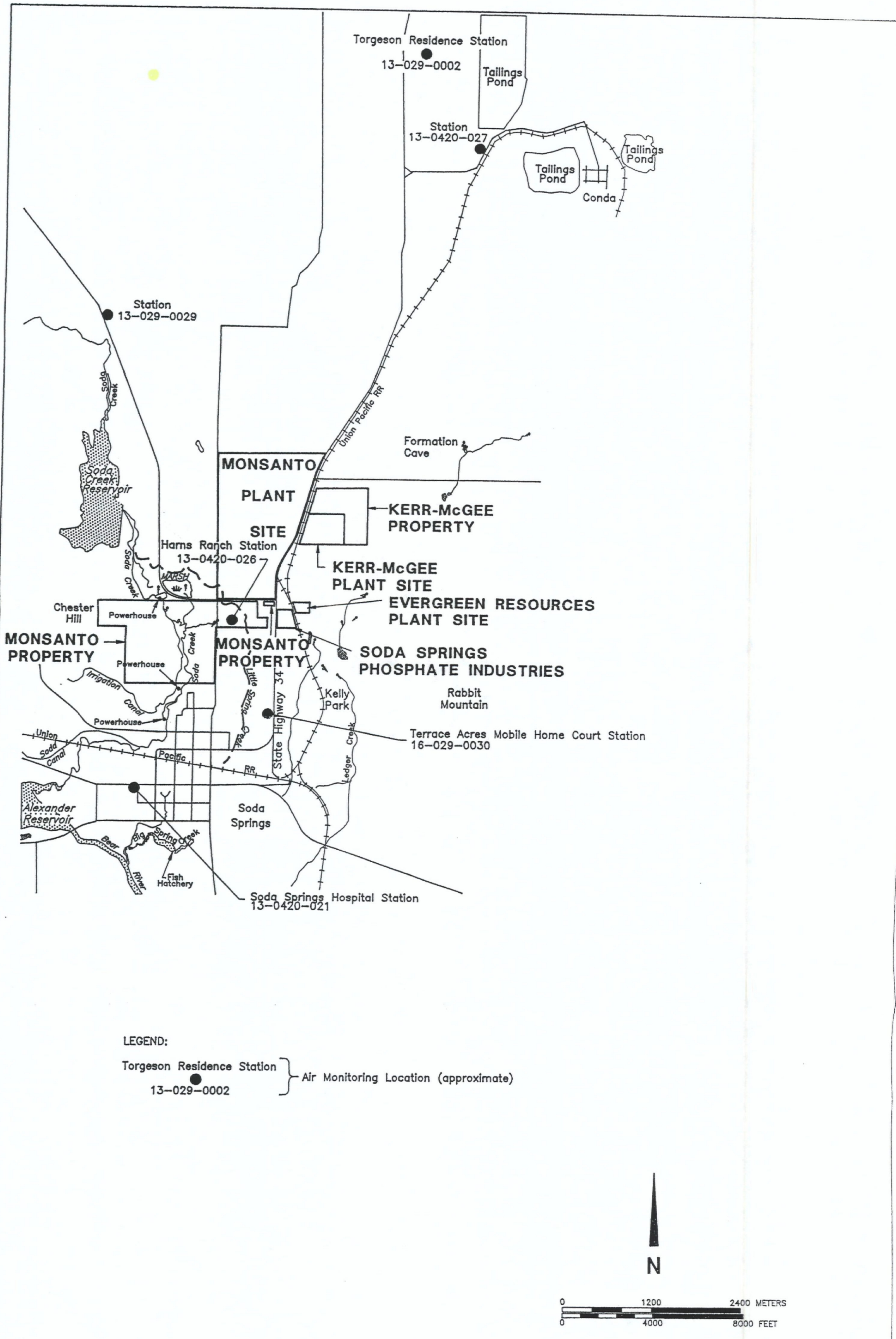

FIGURE 1-6
AIR MONITORING LOCATIONS
MONSANTO/PHASE I FS REPORT/ID

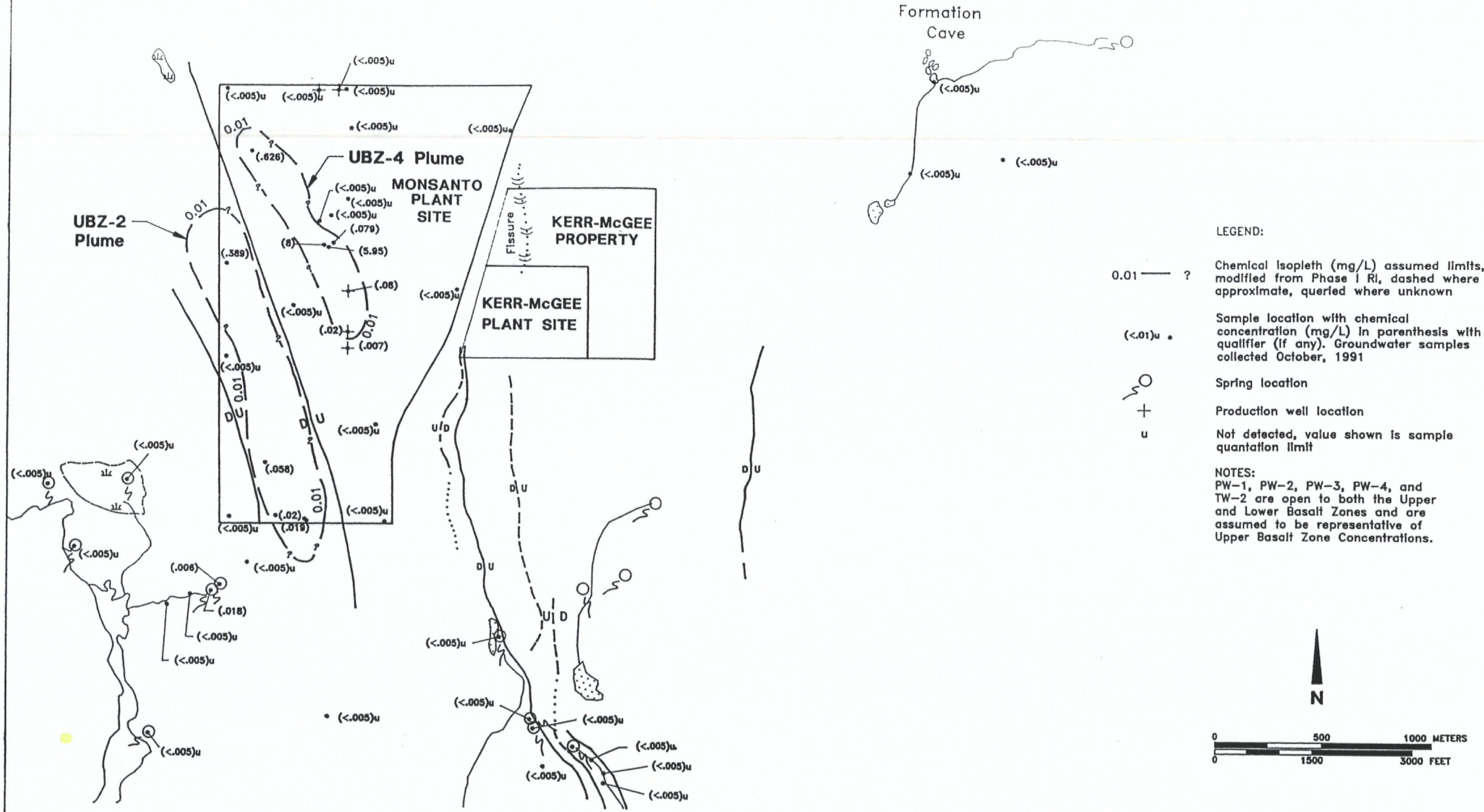

FIGURE 3-1
UPPER BASALT ZONE CADMIUM
MONSANTO/PHASE I FS REPORT/ID

PROJECT NO 913-1101.309 DWG NO 31750 DATE 6-4-92 DRAWN PM

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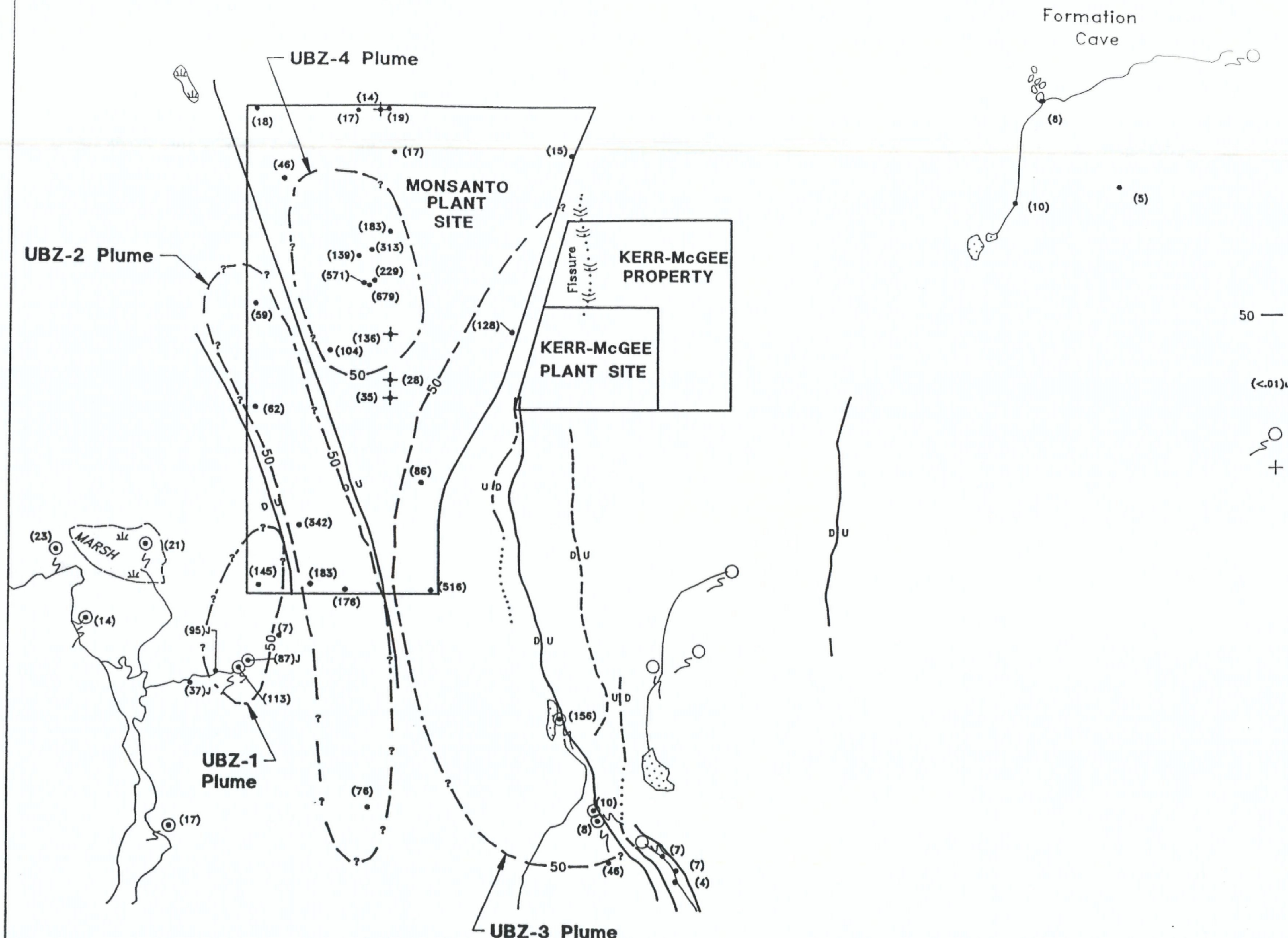

LEGEND:

50 — — ? Chemical isopleth (mg/L) assumed limits, modified from Phase I RI, dashed where approximate, queried where unknown

(<.01)u • Sample location with chemical concentration (mg/L) in parenthesis with qualifier (if any). Groundwater samples collected October, 1991

Spring location

\+ Production well location

NOTES:
PW-1, PW-2, PW-3, PW-4, and TW-2 are open to both the Upper and Lower Basalt Zones and are assumed to be representative of Upper Basalt Zone concentrations.

FIGURE **3-2**
UPPER BASALT ZONE CHLORIDE
MONSANTO/PHASE I FS REPORT/ID

PROJECT NO 913-1101.309 DWG NO 31749 DATE 5-18-92 DRAWN PM

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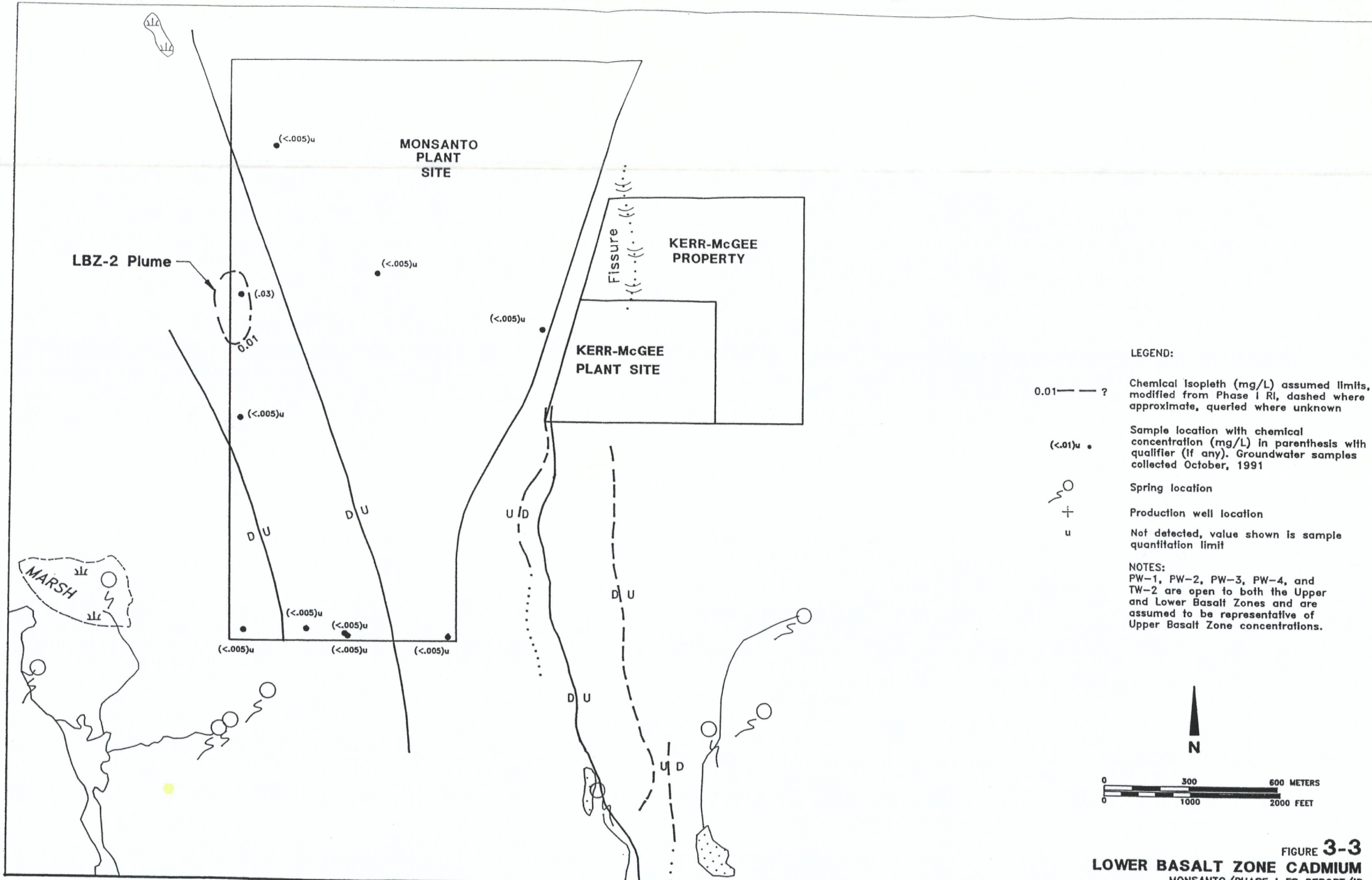

FIGURE 3-3
LOWER BASALT ZONE CADMIUM
MONSANTO/PHASE I FS REPORT/ID

PROJECT NO 913-1101.309 DWG NO 31433 DATE 6-4-92 DRAWN PM

Golder Associates

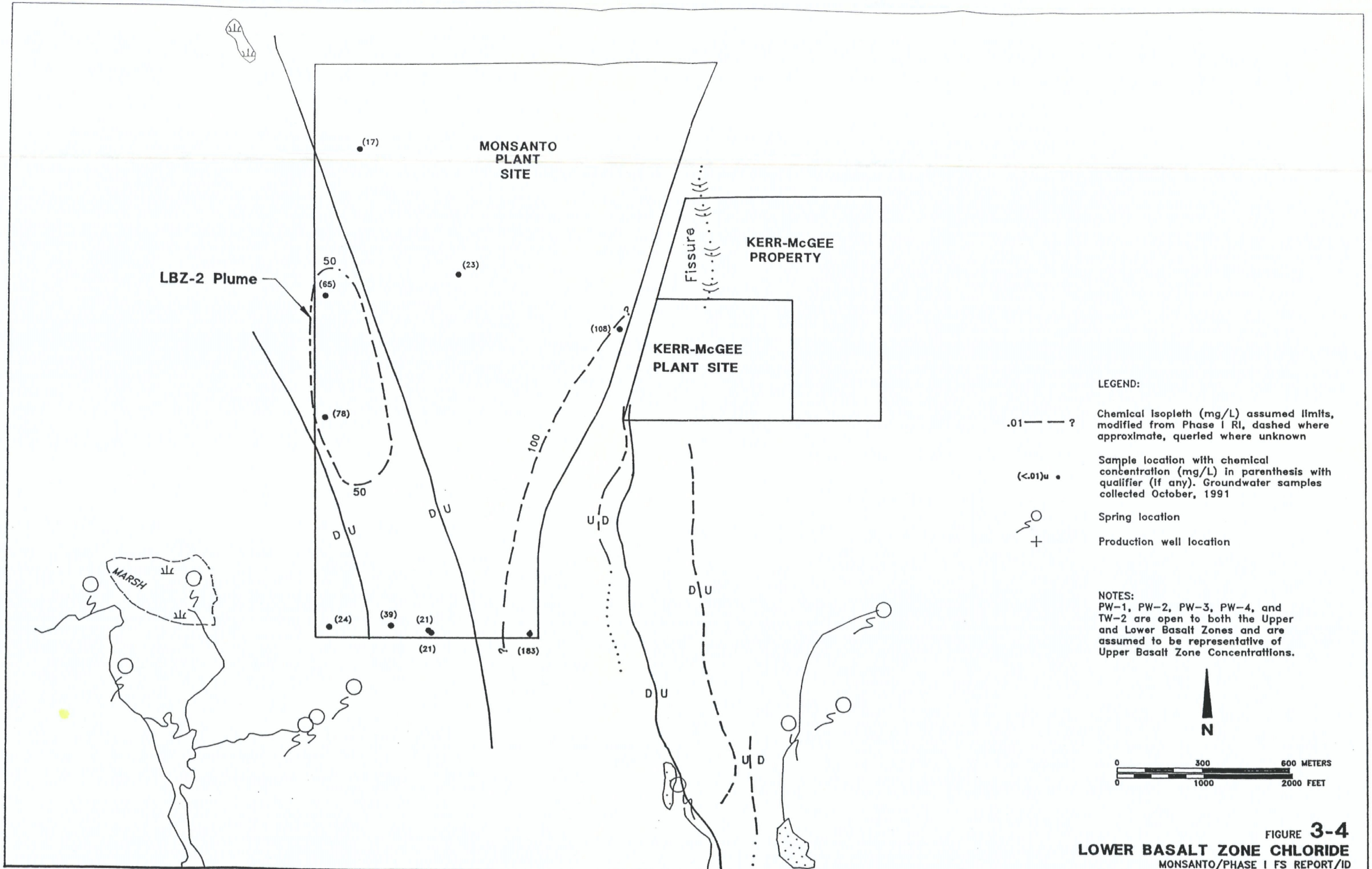

FIGURE 3-4
LOWER BASALT ZONE CHLORIDE
MONSANTO/PHASE I FS REPORT/ID

PROJECT NO 913-1101.309 DWG NO 31432 DATE 6-3-92 DRAWN PM

Golder Associates

APPENDIX A

MEMORANDA AND LETTERS CITED

STATE OF IDAHO

DEPARTMENT OF HEALTH AND WELFARE

DIVISION OF ENVIRONMENT
Pocatello

22 Mar 76

MEMO TO: Gordon J. Hopson

FROM : Jim Perry

SUBJECT: Soda Creek Study and Input from Monsanto Co.

When I arrived Friday, there was a message to call Perry Warner of Monsanto Co. about the Soda Creek Report. Henry said that he had called Bob, and the latest word was not to release reports until we had approval from Boise; so, Henry said he would call Perry to see what he wanted to discuss. He also took the note as a reminder.

Perry, and Kent Lott called at 3:30 P.M., and Henry was not in the office. He had not called them yet either. They had the following comments on the Soda Creek Study:

(Comments refer to Page 10)

Average discharge from Monsanto in August was 6038 cubic meters per day, maximum was 7986.

These are values as cubic meters per day, not per second as reported. The 8052 value was average for July 1975.

The 8052 cms d translates to 3.291 cfs; the 7986 cms d translates to 3.26 cfs.

If one then uses these values in the calculation, the resultant K factor becomes 1.055.

The table below then becomes:

Controlled Value	Resultant Maximum
Flow 10,100 M^3/day (4.13 cfs)	116.2°F
Flow 12,100 M^3/day (4.95 cfs)	107.6°F
Temperature - 80°F	13.69 cfs
Temperature - 90°F	8.35 cfs

6145c
3.144

Those values assume a [illegible] F increase in the temperature of [illegible]. If the stream classification were not changed, and only [illegible] 0.[illegible]F increase allowed, the table would be as follows:

Controlled Value	Resultant Maximum
Flow 10,100 M^3/day (4.13 cfs)	99.[illegible]F
Flow 12,100 M^3/day (4.95 cfs)	92.[illegible]F
Temperature - 80°F	8.7[illegible] cfs
Temperature - 90°F	5.84 cfs

It should also be stressed that this is a predictive technique that has been used to give us a handle on the situation. It definitely needs to be checked empirically before we make any firm use of it.

If further predictions need to be made with the formula, the following relations can be used:

UF = Upstream Flow
UT = Upstream Temperature
EF = Effluent Flow
ET = Effluent Temperature
F = Cooling Factor ([illegible])
DF = Downstream Temperature

$$\text{Effluent Temperature} = \frac{F\,[(UF+EF)(DT)] - (UF)(UT)}{EF}$$

$$\text{Effluent Flow} = \frac{UF\,[(F)(DT) - UT]}{ET - (F)(DT)}$$

cc: Henry Moran

A SURVEY OF WATER QUALITY AND BENTHIC POPULATIONS OF SODA CREEK, CARIBOU COUNTY, IDAHO, AS INFLUENCED BY POINT SOURCE EFFLUENTS

Soda Creek drains a small watershed in Caribou County, Idaho. It has a drainage area of about 46 square miles and an average discharge of 16.8 cfs at 5-mile Meadow (about five miles north of Soda Springs). Near the mouth, the discharge is about 52 cfs, with as much as 75% derived from groundwater (Dion, 1969). Hooper Spring, which enters the creek at River Mile 4, is highly mineralized and has a very high CO_2 content. Monsanto Industrial Chemicals Company has a point source discharge to Soda Creek about one-half mile below Hooper Spring. This effluent is high in phosphorus, nitrate, and sulphate. The effluent also has a high thermal load.

Monsanto has requested that the temperature and flow restrictions be removed from their NPDES discharge permit. They feel their request is justified due to:

(1) The quality of the water in the creek
(2) The negligible effect they feel their effluent has on the creek
(3) The low fish population in the creek

This study was undertaken to measure water quality and benthic populations of Soda Creek and to make recommendations concerning those permit limitations.

Five stations were chosen on Soda Creek:

Station 1 is above the confluence with Hooper Spring. It is located near the bridge at the upper edge of Hooper Spring Park.

Station 2 is located at the bridge that provides access to the power station below Hooper Spring. This is about 0.2 miles below the spring.

Station 3 consists of Monsanto's effluent to the river, about 0.5 mile below Hooper Spring.

Station 4 is located about 0.1 mile below Monsanto's confluence with the creek.

Station 5 is located just upstream from the bridge where U.S. Highway 30 North crosses Soda Creek, outside of Soda Springs. This is about River Mile 1.0.

Water samples were grab samples taken from mid-stream. Benthic
les were taken with a fish net. Samples were taken in April, June,
ptember, and December, 1975. Fish sampling was done with John Heimer,
gional Fisheries Manager, Idaho Department of Fish and Game, with a
k-Pack-Shocker." Shocking was done at all stream stations on
23, 1975.

ts:

r Quality:

Mean values for the water quality parameters are listed in Appendix I.
gh Monsanto's effluent is high in several parameters, there does not
to be a corresponding increase in those parameters in the creek. There
neral downstream increase in several parameters, but few changes are
cally associated with a point source. Those changes that are associated
a point source are as follows:

Spring - increases in nitrate, hardness, conductivity and iron.
ses in ortho-phosphate and zinc. With the latter, this seems to be a
of precipitation, as pH and alkalinity are both known to affect
bility of zinc, as are the concentrations of several other metalic

Outfall: An increase in nitrate is apparent. Iron increases, but
due to the outfall. Decreases are seen in all three phosphorus
e., even though the effluent has a high phosphorus loading. This
is probably due to temperature effects on the equilibria of these
s.

ures of Soda Creek: Monsanto Company took several temperature readings
eek in January. An extensive series of instantaneous readings were
une as part of this study. Results of all those measurements are
as Appendix 2 (Monsanto) and Appendix 2 (this study). The Monsanto
ises the temperature of Soda Creek approximately 3° C directly
ffluent. There is an increase of 1.5° C to 1.0° C below the
in the creek, and 2° C below the effluent in the irrigation canal.

ions:

sh were located at Stations 1, 2, or 4. One rainbow trout was
r Station 5, and two more fish (assumedly, rainbow trout) were
ater. This is not a conclusive population estimate, but is
of the fact that this is a harsh environment, with at least a
ced fish population. Apparently, at least, some game fish are
e lower part of the creek.

tebrate Populations:

difficulty was experienced at Station 5, so diversity indices
d n the Upper three stream stations only. The diversity values
ons are shown in Appendix 4 in tabular form. The diversity

indices seem to indicate that Hooper Spring severely affects the benthic populations. These populations then slowly recover downstream from the spring. Monsanto discharges to a pool area above an irrigation dam. It is to be expected that the Soda Creek ecosystem is affected within the area between the dam and outfall. However, the effect does not seem to extend below the dam.

Conclusions:

1. There is an ecosystem comprised of "other aquatic life" below the Monsanto outfall in Soda Creek. The creek is not "barren" due to water quality or any other consideration.

2. The only demonstrable effects of the Monsanto outfall were:

   (1) A minor increase in nitrate
   (2) A decrease in phosphorus, both total and dissolved
   (3) An increase in temperature of 2 degrees centigrade or less directly below the effluent.

Appendix 1. Mean Values of Chemical Parameters from Soda Creek Quarterly Samples.

Parameter	SC-1 Above Hooper Spring	SC-2 Between Hooper and Monsanto	SC-4 Below Monsanto	SC-5 At Soda Springs	SC-3 Monsanto Effluent
Ammonia	0.76	0.88	0.77	0.84	0.19
Nitrite	0.004	0.006	0.007	0.007	0.015
Nitrate	0.88	1.33	1.88	2.13	10.4
Total Kjeldahl Nitrogen	1.30	1.60	1.50	2.25	1.92
Ortho-Phosphate	0.22	0.13	0.07	0.29	11.4
Total Inorganic Phosphorus	0.62	0.68 .55	0.35	0.63	17.5 6-7
Total Phosphorus	0.21	0.24	0.13	0.22	5.9
Total Hardness	239.0	490.5	442.0	495.5	456.0
Total Alkalinity	481.5	487.5	442.5	481.0	350.0
Sulphate	29.0	37.5	32.1	41.9	87.6
Conductivity	760.0	857.5	732.5	822.5	892.5
Fluoride	0.40	0.34	0.23	0.34	1.18
Chloride	2.0	2.5	2.0	2.0	2.25
Iron	0.28	0.68	0.88	0.60	0.07
Manganese	72.5	80.0	67.5	87.5	27.5
Sodium	19.3	19.2	18.3	20.5	40.7
Potassium	7.7	8.1	7.6	8.2	12.0
Copper	0.001	< 0.001	0.001	0.001	0.003
Lead	0.003	< 0.001	< 0.001	0.001	< 0.001
Selenium	< 0.001	< 0.001	< 0.001	0.001	0.016
Zinc	0.027	0.005	0.014	0.005	0.360

Appendix 2. Monsanto Temperature Readings from Soda Creek, Measured in January.

Temperature, °C	Sampling Site
2.8	Above outfall.
2.9	Average of six readings across headgates of the east and west canal below outfall.
3.2	Average of readings on east and west canal, 150 yards below outfall.
3.2	At convergence point.
4.0	At next culvert (approximately 1/4 mile).
4.0	At next culvert (approximately 1/4 mile).
2.9	Into Reservoir.

Appendix 3. Temperatures of Soda Creek and the Monsanto Outfall, on June 18, 1975.

Station 1. Above Hooper Spring

Stream 4 meters wide, temperature 11° C on each edge and at each one meter interval across the stream.

Station 2. Between Hooper and Monsanto

Stream 4 meters wide, temperature 11° C on each edge and at each one meter interval across the stream.

Station 3. Monsanto Effluent: 23° C.

Soda Creek at the Monsanto Effluent

Stream 11 meters wide, effluent enters south bank. Measurements from North to South at one meter intervals.

North Bank	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	South Bank
12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	11.5	12.0	12.5

Soda Creek at the Irrigation Dam, Below the Effluent

The Dam is 14 meters wide. The irrigation diversion leaves the south edge of the dam. Measurements are at one meter intervals across the face of the dam.

North Bank	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10 m	11 m	12 m	13 m	South Bank
11.5	12.0	12.0	12.0	12.0	12.0	12.5	12.5	12.5	13.0	13.0	13.0	13.5	14.0	14.0

Station 4, Soda Creek about 75 Meters Below the Outfall

Stream is five meters wide. Temperature 12.5° C on each bank and at each meter across the stream.

Soda Creek About 150 Meters Below the Outfall

Stream is eight meters wide. Temperature is 12.0° C on each bank and at each meter across the stream.

Irrigation Canal, About 75 Meters Below the Outfall

Seven meters wide, uniform 13° C.

Appendix 3. (Continued)

Irrigation Canal About 150 Meters Below the Outfall

Six meters wide, uniform 13° C.

Soda Creek at the Confluence of the Irrigation Canal and the Creek.

Three readings: 13° C Average

Soda Creek at the Next Culvert

Three Readings: 12° C Average

Soda Creek at the Next Culvert

Three readings: 12.5° C Average

Station 5, Soda Creek at Highway 91 Bridge

Five Readings: 12.0° C Average

Appendix 4. Benthic Species Diversity

Station	April	June	September	December	Mean
1	1.945	0.293	0.645	1.246	1.032
2	0.712	0.926	0.994	1.210	0.961
3	1.758	1.210	1.024	1.084	1.269
4	N/A	N/A	N/A	N/A	N/A

Recommendations:

Four points were raised by Monsanto in their request for a permit modification. This study attempted to find answers to those points, and these recommendations present those findings:

1. What should be the boundaries of an equitable mixing zone for the Monsanto outfall in Soda Creek?

2. Can stream classification be changed to Class E?

3. Is 90° F too hot for an effluent to Soda Creek?

4. Can flow be eliminated as a parameter limitation from the Monsanto Permit?

The mixing zone should be defined as follows:

The full width of the stream, from surface to stream bottom, and extending from a point one meter above the Monsanto effluent, exactly to a point of the irrigation dam below the effluent, approximately ten meters downstream. If this recommendation is enacted, this distance should be measured and the exact distance specified in a NPDES Permit revision.

We feel that it is reasonable to reclassify Soda Creek as a Class E stream. The uses to be protected would be:

Domestic Water Supply
Industrial Water Supply
Irrigation
Livestock Watering
Other Fishing and Aquatic Life
Hunting and Wildlife
Aesthetics

In accord with the E Classification, temperature increase of 2° F from that one source (Monsanto) would be allowed. This is in contrast to the 0.5° F increase allowed in a Class A_2 stream.

It should also be specified that the industry will measure stream temperature above and below their mixing zone. The temperature shall be measured with a maximum-minimum recording thermometer, which shall be checked and re-set daily. The temperature shall be measured on a permanent installation within two meters of the upper and lower boundaries of the mixing zone. Temperatures will be measured at the center of the stream. There will be no more than 2° F difference between the two temperature measurements on any given day. Temperature measuring device must be installed within thirty days from the effective date of this permit change. The installation will be approved by personnel from the Idaho Department of Health and Welfare, Division of Environment, and/or Idaho Operations Office of the U.S. Environmental Protection Agency. Weekly averages of the temperature readings will be reported on the Discharge Monitoring Reports submitted quarterly to the EPA and the State.

Using data from the most extreme conditions (August), we have calculated the approximate cooling that is taking place within that designated mixing zone. These calculations are presented in Appendix 4. Using this information, we have estimated the allowable temperature-flow combinations that would not exceed this 2° F increase. Any combination of temperature and flow between these extremes would be acceptable.

<u>If Flow Is:</u>	<u>Temperature Maximum Should Be:</u>
10,100 M^3/Day (41.28 cfs)	83.7° F
12,100 M^3/Day (49.46 cfs)	81.8° F
<u>If Temperature Is:</u>	<u>Flow Should Be Restricted To:</u>
90° F	(26.83 cfs) 6564 M^3/Day

Appendix 5.

In August, when the creek would be expected to be at extreme conditions, Soda Creek temperatures were as follows:

Above Monsanto	15° C	59° F
Monsanto Effluent	24° C	75.3° F
Below Proposed Mixing Zone	14° C	57.1° F

Flows in Soda Creek at Five-mile Meadow average 23 cfs and have minima as low as 12 cfs. Hooper Spring, as well as several other springs, enter Soda Creek above the Monsanto outfall. Dion (1969), reported flows of Soda Creek at the mouth as 52 cfs. Therefore, an estimated flow of 40 cfs in August was used in the following calculations:

The average discharge from the Monsanto plant in August, 1975, was 8052 cubic meters per second (32.91 cfs). This information allows the calculation of a factor which relates the cooling taking place in the mixing zone. This calculation is as follows:

<u>Upstream</u> + <u>Effluent</u> = (<u>Factor</u>) [(Resultant Flow)(Resultant Temp.)]

(40 cfs)(59° F) + (32.91 cfs)(75.3° F) = K [(40 + 32.91)(57.1° F)]

The Resultant Factor is 1.162.

This cooling factor allows a calculation for maximum temperature of a given quantity of discharge or maximum discharge for a given temperature. As a test of the calculation, The data for a sample taken in June were entered into the formula and an attempt made to predict downstream temperature if the remaining values were known. The predicted value was 53.9° F and the observed value was 54.3° F. The 0.5° F represents the limits of the test. The following table illustrates limits for the Monsanto effluent:

Controlled Value	Resultant Maximum
Flow - 10,100 M^3/Day (41.28 cfs)	83.7° F
Flow - 12,100 M^3/Day (49.46 cfs)	81.8° F
Temperature - 80° F	60.55 cfs
Temperature - 90° F	26.83 cfs
Temperature - 81.8° F	49.38 cfs

The conclusions reached by these calculations are:

Monsanto will probably not violate proposed water quality limits with the present limits on their permit; i.e., 10,100 M^3/Day and 80° F.

They probably do now (and did on June 18, 1975) violate present water quality limits; i.e., they increase the temperature more than 0.5° F outside their mixing zone boundaries.

If the stream is re-classified to Class E, allowing a temperature increase of 2° F at any time from a single source, an equitable solution will be possible. This will allow a temperature-flow limit to be placed on the effluent in whatever combination Monsanto feels most comfortable with (as in above table).

Monsanto

APR 12 1988

FROM (NAME—LOCATION—PHONE) C. K. Cheng (4-6178) MCC Environmental Systems - F2WJ

DATE : April 8, 1988

SUBJECT : Worldwide Guideline #1
Air Dispersion Modeling

REFERENCE :

TO : F. R. Johannsen - A3ND

cc: J. P. Hyland - G4WT
C. D. Malloch - A3NA
K. J. Perry - F2WJ
O. S. Ratterman - F2WJ
J. M. Schroy - F2WJ
J. H. Waldbesser - F2WJ
D. R. Wind - 1850

Enclosed are the results of IEM air dispersion modeling for Cadmium at Soda Springs.

Chi Kit Cheng
C. K. Cheng

/jt

Enclosure

NNC - 0.05
ave - 0.00126

Transmittal of IEM Results to DMHS from Environmental Systems

Plant Soda Springs

Chemical Cadmium

Priority 1

Collective exposure (person -$\mu g/m^3$) 17.5

Maximum hypothetical concentration ($\mu g/m^3$) 0.20

Nearest neighbor concentration ($\mu g/m^3$) 0.05

Tables showing these values appear in the attached IEM printouts.

From C. K. Cheng
Date April 8, 1988

MONSANTO CONFIDENTIAL

Soda Springs

The information herein is current as of: June 22, 1988

Cadmium

There are no current federal ambient air standards for cadmium under the Clean Air Act. The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 100 micrograms of cadmium per cubic meter of air (100 $\mu g/m^3$) to prevent kidney and lung injury in workers. The American Conference of Governmental Industrial Hygienists (ACGIH) have proposed a Threshold Limit Value (TLV) of 10 micrograms per cubic meter (10 $\mu g/m^3$) to protect workers against kidney and lung injury and the risk of lung cancer.

Estimated routine plant emissions can be used with computer modeling to calculate an annual average air concentration of cadmium for the surrounding community as a whole and for specific geographic locations. These calculations can be used to estimate a hypothetical annual average exposure of the community and a higher maximum annual average concentration for some individuals because of variations in geographic and meteorologic patterns. The model does not precisely predict actual ground level concentrations because of variability in atmospheric conditions. These values are considered conservative, i.e., it has been demonstrated that such predicted air concentrations are higher than actual measured values. Also, continuous annual operation is assumed for these computer estimates. The emission numbers are thus worst case since no plant operation runs continuously over a full year. The emission numbers reported annually under Section 313 will not be greater and likely be less. Nevertheless, these calculated ground level dispersion concentrations can be useful for planning and evaluation purposes.

Computer modeling provides the following information for assessment purposes. The estimated annual average community air concentration resulting from plant emissions is 0.0013 micrograms of cadmium per cubic meter of air (0.0013 $\mu g/m^3$). For a simple comparison, the TLV proposed for workers by ACGIH is 7,700 times higher. Due to geographic and meteorologic variations, the higher estimated annual average air concentration for some individuals is predicted as 0.05 micrograms per cubic meter of air (0.05 $\mu g/m^3$). The TLV level proposed by ACGIH is 200 times higher. In both instances, the substantial margins of safety over and above the occupational exposure level (TLV) proposed by ACGIH leads to a conclusion that routine plant emissions of cadmium will not produce kidney or lung injury in the community.

In its proposal, ACGIH concluded that persons exposed to cadmium below 10 micrograms per cubic meter of air (10 $\mu g/m^3$) would not be at increased risk for lung cancer. Since there are differences in the exposure patterns of workers and neighborhood residents, the air concentrations of cadmium estimated by computer modeling can be adjusted to allow for those differences. When this is done, the ACGIH proposed level (TLV) of worker exposure is over 1,500 times higher than the estimated annual average community air concentration and about 40 times higher than the annual average air concentration for the most exposed individuals.

A single long-term inhalation study in animals has shown an increased incidence of lung cancer. An epidemiology study of workers exposed to high cadmium levels also showed a slightly increased level of lung cancer. Further research is needed to determine the significance to humans of exposures at much lower levels which might be present in the ambient air.

After considering factors such as differences in age, susceptibility, possible pre-existing disease and other variables between workers and residents, and based upon an evaluation of all of the scientific evidence, the routine emissions of cadmium from our plant are considered safe for human health, but that more precise studies of emission rates and possible options for reduction are indicated.

7

Monsanto

MAY 17 1988

FROM (NAME—LOCATION—PHONE) C. K. Cheng (4-6178) MCC Environmental Systems - F2WJ

DATE : May 16, 1988

SUBJECT : Worldwide Guideline #1
Air Dispersion Modeling

REFERENCE :

TO : F. R. Johannsen - A3ND FCR

cc: J. P. Hyland - G4WT
C. D. Malloch - A3NA
K. J. Perry - F2WJ
O. S. Ratterman - F2WJ
J. M. Schroy - F2WJ
J. H. Waldbeser - F2WJ
D. R. Wind - 1850

Enclosed are the results of IEM air dispersion modeling for HF at Soda Springs.

C. K. Cheng

C. K. Cheng

/jt

Enclosure

Transmittal of IEM Results to DMHS from Environmental Systems

Plant Soda Springs

Chemical HF

Priority 1

Average individual exposure ($\mu g/m^3$) 0.06

Maximum hypothetical concentration ($\mu g/m^3$) 32.8

Nearest neighbor concentration ($\mu g/m^3$) 7.6

Tables showing these values appear in the attached IEM printouts.

From C. K. Cheng
Date May 16, 1988

Soda Springs

MONSANTO CONFIDENTIAL

This information herein is current as of: June 22, 1988

Hydrogen Fluoride

There are no current federal ambient air standards for hydrogen fluoride under the Clean Air Act. The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have each set 3,000 parts of hydrogen fluoride per billion parts of air (3,000 ppb) for protection of workers to prevent primary irritation of the skin, eyes, mucous membranes and the lungs. It also prevents skeletal changes called fluorosis which may be caused by prolonged, excessive exposure to hydrogen fluoride.

Estimated routine plant emissions can be used with computer modeling to calculate an annual average air concentration of hydrogen fluoride for the surrounding community as a whole and for specific geographic locations. These calculations can be used to estimate a hypothetical annual average exposure of the community and a higher maximum annual average concentration for some individuals because of variations in geographic and meteorologic patterns. The model does not precisely predict actual ground level concentrations because of variability in atmospheric conditions. These values are considered conservative, i.e., it has been demonstrated that such predicted air concentrations are higher than actual measured values. Also, continuous annual operation is assumed for these computer estimates. The emission numbers are thus worst case since no plant operation runs continuously over a full year. The emission numbers reported annually under Section 313 will not be greater and likely will be less. Nevertheless, these calculated ground level dispersion concentrations can be useful for planning and evaluation purposes.

Computer modeling provides the following information for assessment purposes. The estimated annual average community air concentration resulting from plant emissions is 0.072 parts of hydrogen fluoride per billion parts of air (0.072 ppb). For a simple comparison, the permitted level for exposure of workers is more than 40,000 times higher. Due to geographic and meteorologic variations, the higher annual average air concentration for some individuals could be 9.1 parts per billion parts of air (9.1 ppb). The permitted worker exposure level is over 300 times higher. In both instances, the substantial margins of safety over and above the permitted occupational exposure level and past human experience lead to a conclusion that the routine emissions of hydrogen fluoride will not be irritating.

Since there are differences in the exposure patterns of workers and neighborhood residents, the air concentrations of hydrogen fluoride estimated by computer modeling can be adjusted to allow for these differences. When this is done, the permitted worker exposure is still 8,000 times higher than the estimated annual average community air concentration and over 60 times the annual average air concentration for the most exposed individuals.

Routine plant emissions also can be compared to the amount of fluoride which could be ingested by drinking water in compliance with the Environmental Protection Agency's National Secondary Drinking Water Regulations. This drinking water standard would permit the daily intake of more than 3,300 times the amount of fluoride that the community might receive from our ambient air emissions and about 25 times the amount the higher annual average air concentration individuals might receive. Again, the margins of safety are sufficient to prevent the occurrence of fluorosis.

After considering factors such as differences in age, susceptibility, possible pre-existing disease and other variables between workers and residents, and based upon an evaluation of all of the scientific evidence, the routine emissions of hydrogen fluoride from our plant are within limits safe for human health.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Boise Field Station
4696 Overland Road, Room 576
Boise, Idaho 83705

RECEIVED
DEC - 5 1991
Golder Associates

RECEIVED
DEC - 5 1991
Golder Associates

December 2, 1991

William E. Wright
Senior Environmental Scientist
Golder Associates, Inc.
4104 148th Avenue NE
Redmond, Washington 98052

Re: Request for a Natural
Heritage Program Database
Review 913-1101.206
(1019.1032) 1-4-92-SP-95

Dear Mr. Wright:

The information you requested regarding listed and proposed endangered and threatened species in the vicinity of the Monsanto Soda Springs Plant is enclosed. In addition to these species, the Conservation Data Center (formerly Heritage Program) listed a willow (_Salix candida_), which occurs along Ledger Creek east of the Plant (T9S, R42E, S5), as Bureau of Land Management and U.S. Forest Service "sensitive".

The U.S. Fish and Wildlife Service (Service) and other Department of Interior agencies submitted a Preliminary Natural Resources Survey on the Monsanto Site to the Environmental Protection Agency in June, 1991. In that document, the Service identified important trust resources and potential contaminant pathways to be considered in any future remedial investigations.

Testing of surface water samples by Ecology and Environment (Ecology and Environment, Inc. 1988. Site Inspection Report for Monsanto Chemical Company, Soda Springs, Idaho. TDD F10-8702-06. 29 pp.) revealed elevated concentrations of selenium, vanadium, and zinc at Mormon Springs, which surfaces near the southwest corner of the Monsanto Site and flows into Soda Creek and ultimately Alexander Reservoir. The effluent discharge water, which flows offsite near the southwest corner of the site and also enters Soda Creek, contains elevated concentrations of aluminum, cadmium, iron, selenium and vanadium.

Significant fish and wildlife habitats located near the Monsanto Site include the Bear River and Alexander Reservoir, located about 2.5 miles southwest of the Site, and Formation Springs, a property owned by the Nature Conservancy located about 1.5 miles northeast of the Site. Grays Lake National Wildlife Refuge is located about 25 miles north of the site.

Key trustee species which inhabit the Bear River/Alexander Reservoir area include bald eagles, white pelicans, Canada geese, and several species of ducks and shorebirds. About 10-12 bald eagles (endangered) winter in the Bear River/Alexander Reservoir area from Soda Springs downstream about 5 miles to Soda Point. White pelicans forage in Alexander Reservoir in the summer, and numerous shorebirds feed on the mudflats of Alexander Reservoir during late summer. Canada geese are found in the area all year, and nest along the Bear River and Alexander Reservoir. Several species of ducks utilize the area during spring and fall migration (Carl Anderson, Idaho Department of Fish and Game, personal communication).

Alexander Reservoir, operated by Utah Power and Light, provides a marginal rainbow trout and yellow perch fishery. It was completely drawn down the past two winters for maintenance work at the dam. The Bear River below the Reservoir supports a fair rainbow trout fishery. Smallmouth bass have also been introduced into this reach (Jim Mende, Idaho Department of Fish and Game, personal communication).

The Service is not aware of any biological sampling that has been done in the vicinity of the Monsanto Site, including the affected spring discharges, Soda Creek, Alexander Reservoir or the Bear River below Alexander Reservoir. There appears to be a strong possibility that plant and/or animal species could be affected by the elevated concentrations of aluminum, cadmium, selenium, vanadium, zinc or other chemical constituents that have been detected in Mormon Springs and the effluent discharge stream, both of which discharge into Soda Creek and eventually Alexander Reservoir. Also, several analytes, including vanadium, were detected in groundwater samples taken from the Kerr-McGee Site (Ecology and Environment, Inc., 1988. Final Site Inspection Report for Kerr-McGee Chemical Corporation, Soda Springs, Idaho. TDD F10-8702-04. 50 pp.). There is some indication this contaminated groundwater may also be contributing to contaminants detected in groundwater and spring water samples taken from the Monsanto Site. Such sampling of biological matrices is necessary to determine if harmful concentrations of these chemical constituents are accumulating in biological systems at potentially harmful levels. Any biological sampling should be designed to address potential contaminants from both the Monsanto Chemical Company and Kerr-McGee Sites since it appears both sites may be contributing contaminants via spring discharge near Soda Creek.

The potential for impacts to trustee resources of the Service from air emissions were not addressed in the Final Site Inspection Report . However, this potential pathway should be addressed since air pollution from the facility frequently drifts over habitats occupied by trustee resources.

In conclusion, information presented in the Ecology and Environment Final Site Inspection Report indicate the probable release of several toxic inorganic constituents into springs which discharge into Soda Creek and ultimately Alexander Reservoir on the Bear River. Such discharges may be impacting natural resources under the trusteeship of the Service, including migratory waterfowl, other migratory birds and endangered species. Sampling of biological resources, including food chain items, is recommended to determine if potential pathways exist between observed discharges of contaminated groundwater and resources under the trusteeship of the Service.

We appreciate the opportunity to discuss the ecological aspects of the remedial investigation you are undertaking for the Monsanto Soda Springs Plant. Please contact Bill Mullins (208/334-1931) of my staff if you have any questions regarding these comments.

William H. Mullins

for Charles H. Lobdell
Field Supervisor

Enclosures

AS REQUESTED
LISTED AND PROPOSED ENDANGERED
AND THREATENED SPECIES, AND CANDIDATE
SPECIES, THAT OCCUR NEAR THE CITY OF SODA SPRINGS

DATE: December 2, 1991
PROJECT NAME: Monsanto Soda Springs Plant
SPECIES LIST NO. FWS 1-4-92-SP-95

LISTED SPECIES	COMMENTS
Bald Eagle (*Haliaeetus leucocephalus*)	Wintering Area

PROPOSED SPECIES

None

CANDIDATE SPECIES

None

OTHER SPECIES

Hoary Willow (*Salix candida*)	BLM & FS Sensitive Species

United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle WA 98101

Alaska
Idaho
Oregon
Washington

EPA

SEP 2 5 1991

Reply To
Attn Of: AT-083

NOTICE OF CASE CLOSURE

913-1101.104

Richard Mahoney
Chief Executive Officer
Monsanto Company
Detergents & Phosphates Division
P.O. Box 816
Soda Springs, Idaho 83276

Dear Mr. Mahoney:

This concerns the June 18-19, 1991, Environmental Protection Agency (EPA) inspection performed by Gary R. McRae at Monsanto Company's Detergents and Phosphates Division, Soda Springs Plant, Soda Springs, Idaho. The inspection was carried out to determine compliance with the PCB (polychlorinated biphenyl) Regulations adopted by EPA pursuant to the Toxic Substances Control Act (TSCA).

We have now completed a review of Mr. McRae's report on this inspection and are pleased to inform you that no apparent violations of the PCB Regulations were documented.

If you have any questions regarding the inspection or the PCB Regulations, please contact Eileen Hayes-Hileman, EPA Region 10, Pesticides and Toxic Substances Section, Mail Stop AT-083, 1200 Sixth Avenue, Seattle, Washington 98101; telephone (206) 553-2584.

Sincerely,

Gil Haselberger, Chief
Toxic Substances Section

cc: Donald R. Wind, Environmental Specialist, Monsanto Company

bcc: List I — KRL
R. L. Geddes
D. P. Beauregard
J. P. Hyland - G4WT
P. H. Smith - E2NK
V. T. Matteucci - G5NR
G. W. Mappes - A2NE
Env. Contact File No. 857
(File: PCB's)

FYI,

D. R. Wind